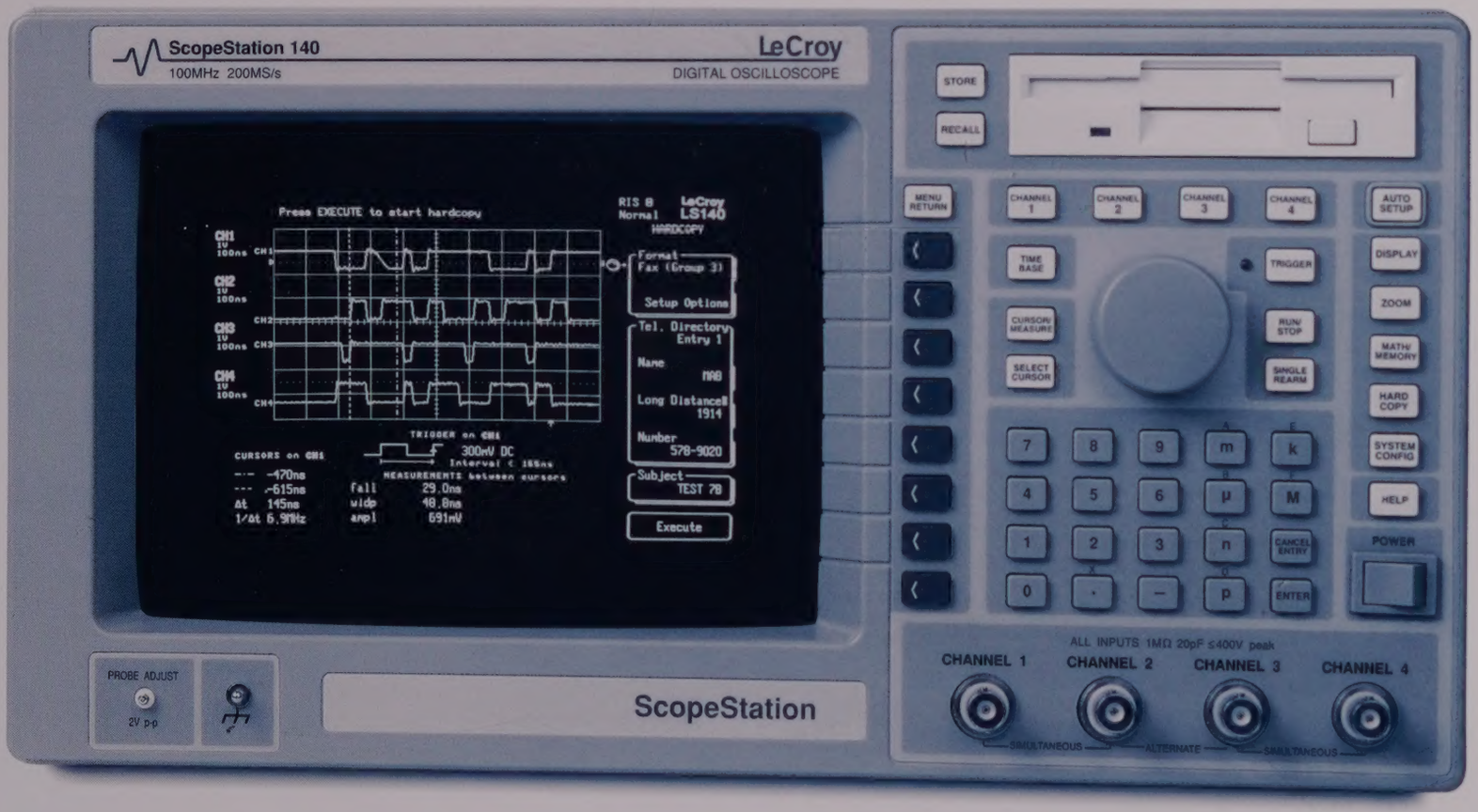
LeCroy LS140 Digital Oscilloscope

Service Manual



LeCroy

Innovators in Instrumentation

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LeCroy CORPORATION

Service Manual

LS140
100 MHz Oscilloscope

September 1993

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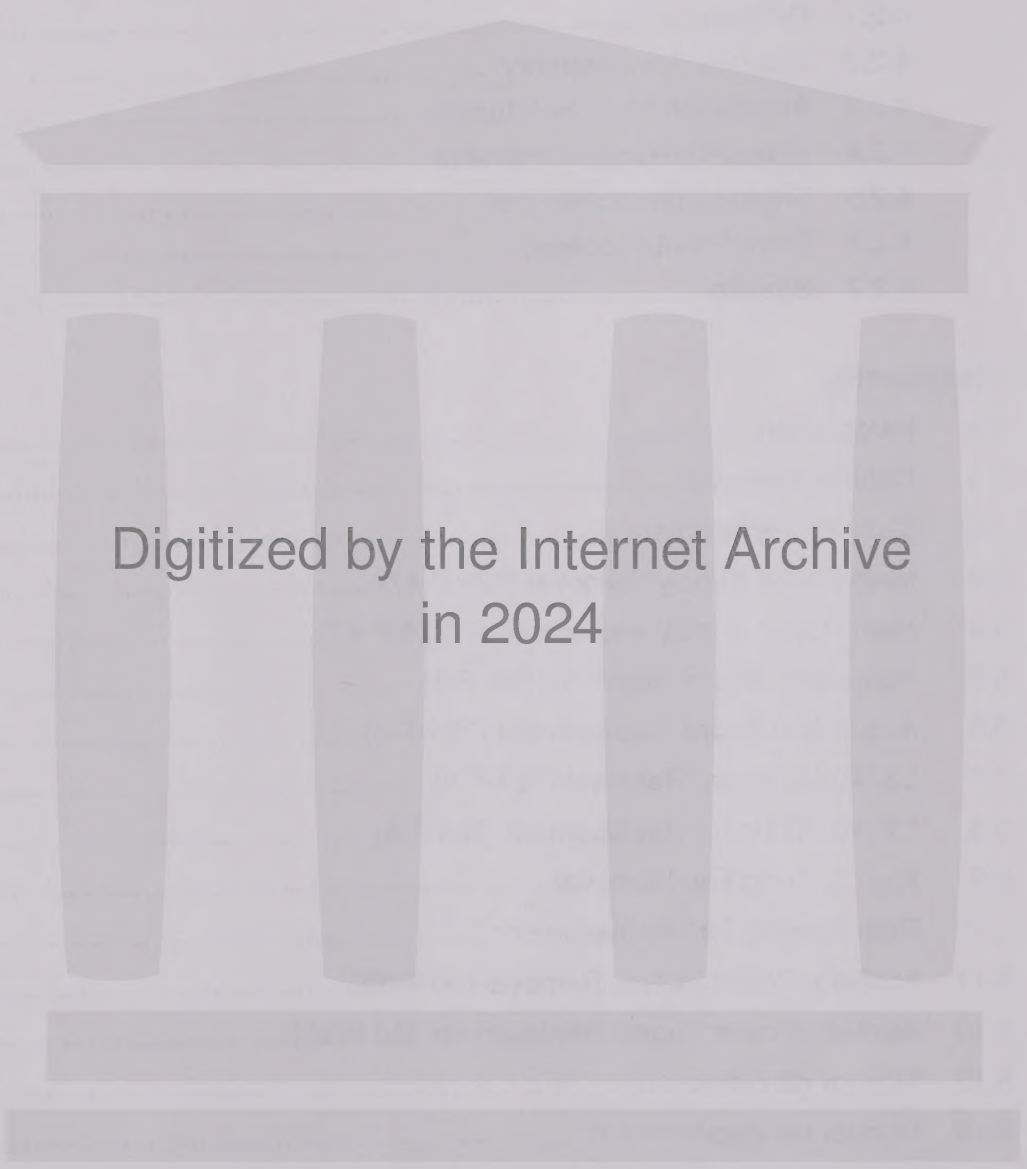

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LECROY LS140 SERVICE MANUAL

General Information

1.0 INTRODUCTION

This service manual contains information to maintain the LeCroy LS140 Digital Oscilloscope. The manual is divided into eight sections as follows:

1. General Information
Contains the LS140 description, specifications, and characteristics.

2. Performance Verification
Contains the performance tests necessary to verify instrument specifications, including recommended test equipment and test record form.

3. Adjustments/Calibration
Contains the necessary procedures to adjust the instrument after servicing.

4. Basic Operation/Block Diagrams
Contains operation descriptions and block diagrams for the instrument.

5. Disassembly
Contains the disassembly and assembly procedures.

6. Troubleshooting
Contains troubleshooting flowcharts to assist in the repair of the instrument.

7. Schematics/Reference Diagrams
Contains schematics and component location diagrams.

8. Parts List
Contains Recommended Spares, Replaceable, and Full parts lists.

Refer to the LeCroy LS140 Operator's manual for information on operating the LS140 and the LeCroy LS140 Remote Programmer's manual for information on programming.

This manual provides replaceable subassembly service information and is not intended to support component level troubleshooting.

1.0 LECROY LS140 SCOPESTATION 100 MHZ PORTABLE DIGITAL OSCILLOSCOPE SPECIFICATIONS

SIGNAL ACQUISITION SYSTEM

Channels: 4

Simultaneous channels: Channels 1 and 2, Channels 3 and 4.

ADC: Two 8-bit Flash.

Bandwidth (-3 dB): 100 MHz, 10 mV/div. to 10V/div.; 70 MHz at 5 mV/div. 35 MHz BWL independently selectable on each channel. Bandwidth is specified for performance at the probe tip.

Gain accuracy: ±2% of full scale ±1% of offset setting (when operated within 10°C of last calibration temperature.)

Vertical resolution: 8 bits

Analog bandwidth selections: 35 MHz and full. Independently selectable for each channel.

Input coupling: AC, DC, or GND.

Input impedance: 1 MΩ ±1% in parallel with 20 pF.

Sensitivity: 5 mV/div to 10 V in 1, 2, 5 sequence. ZOOM extends max. sensitivity to 500 microvolts per division.

Input offset range: ±1 V from 5 mV/div to 100 mV/div
±10 V from 200 mV /div to 1 V/div
±100 V from 2 V/div to 10 V/div

Maximum input voltage: ± 400 V, DC + peak AC (maximum 10 kHz).

Channel isolation: >40 dB at 100 MHz, for channels set to same V/div.

AC-coupled low frequency limit: < 10 Hz.

Probe Sense: Sense ring automatically rescales sensitivity. Probe attenuation factors of X1, X10, X100.

ACQUISITION

Single shot acquisition on timebase ranges 0.2µs/Div and lower. Equivalent time on 0.1µs/Div to 5ns/Div, with maximum equivalent sample rate of 8GS/sec (125ps/Sample).

Zoom extends timebase range to 50ps/Div.

Single shot acquisition modes are:
Alias protect "Off": Maximum sample rate 200MS/sec.

Alias protect "On": Maintains maximum 200 MS/s sample rate on all single-shot timebase ranges. Reduces aliasing and allows fast glitch capture.

Envelope: See Waveform Processing.

Average: See Waveform Processing.

TIME BASE SYSTEM

Sampling rate: Single shot - 200 MS/sec. Repetitive - 8 GS/sec.

Time per division range: 5 nsec to 50 sec/div.

Timebase accuracy: ±0.01%.

Record length: 2K samples per channel.

Pre-trigger selectable from: 0 to 100% of record length with sample point resolution.

Delay: 0 to 10,000 divisions with sample point resolution.

TRIGGER SYSTEM

Triggers: Edge or Smart Trigger™.

Main trigger modes: Auto, Normal, Single (using run/stop & single rearm).

Coupling: DC, DC bandwidth limit, AC, LF reject, HF reject.

Trigger Source Selections: CH1, CH2, CH3, CH4, Line.

Slope: Positive, Negative

SMART TRIGGER™

Hold-off by time: 40 nsec to 80 sec (resolution of 20 nsec).

Hold-off by events: 1 to 10^9 (trigger rate 25MHz max).

TV trigger: Stable triggering on TV signals that comply with PAL, SECAM, NTSC standards.

Selection on both line and field number.

Glitch and width: Trigger on pulse width > or < the operator set limit. Trigger on glitches as small as 10 nsec.

Width > (10 nsec to 80 sec).
Width < (10 nsec to 80 sec).

Resolution: 5 nsec.

Rearm time: 30 nsec.

Interval: Trigger on pulse distances < or > the operator set limit.

Interval > (10 nsec to 80 sec).
Interval < (10 nsec to 80 sec).

Resolution: 5 nsec.

Rearm time: 30 nsec.

DISPLAY

Waveform style: Dots, vectors, or infinite persistence.

Display types: Single, dual, quad, single and XY, full screen XY, 12 and 24 trace cascade.

Waveform displays: Up to 8 waveforms or one Cascade display.

Size: 9 inches diagonally.

Resolution: 640 x 480

Color: Amber

Video Output: VGA compatible monitors.

Real Time Clock: Date, hours, minutes & seconds

CURSOR MEASUREMENTS

Cursor types: Amplitude, time, attached (relative or absolute), logic level, and measurement gate.

Attached: Two cross-hair markers measure time relative to the trigger, time relative to each other. Absolute voltage relative to

signal ground, and voltage relative to each other.

Time: Two vertical bars provide time and frequency measurements.

Amplitude: Two horizontal bars provide amplitude measurements.

Logic level: Four horizontal bars mark the levels for VIL, VIH, VOL, VOH. The logic cursors may be preset for: TTL, ECL, 5 V CMOS, 10 V CMOS, and 15 V CMOS logic.

Measure gate: Portions of the record can be measured by positioning measurement gate cursors to bracket a selected area of the waveform.

AUTOMATIC MEASUREMENTS

Automatic measurements are based upon the ANSI/IEEE Standard. The following twenty measurements are standard of which any six may be displayed in a live, updating fashion.

Amplitude	Base
Cycles	Delay
Duty Cycle	Frequency
Fall Time	Mean
Maximum	Minimum
Overshoot Positive	OvershootNegative
Period	StandardDeviation
Peak to Peak	RMS
Rise Time	Top
Width Negative	Width Positive

WAVEFORM PROCESSING

Waveform functions: Continuous averaging, envelope, floor, roof, zoom.

Arithmetic operators: Add, subtract, and invert, and smooth.

Averaging: 1-127 acquisitions. Continuous averaging.

Envelope: Envelope of MIN and MAX sample values acquired over 1 or more acquisitions.

Floor: MIN values acquired over 1 or more acquisitions.

Roof: MAX values acquired over 1 or more acquisitions.

Zoom: Zoom feature allows waveforms to be expanded, compressed, and positioned both horizontally and vertically.

Vertical Zoom Factor: Up to 10X.

Horizontal Zoom Factor: Up to 100X.

Smooth: Applies an Enhanced Resolution filter to reduce noise on single shot signals.

HARDCOPY

Printers: Canon® BubbleJet, Epson® MX, Epson FX, Epson LQ, HP®-ThinkJet, HP-DeskJet, HP-LaserJet, HP-QuietJet

Plotters: HPGL.

Graphics formats: PCX, TIFF, BMP.

STORAGE

Floppy disk: 3.5" 1.44 Mbyte DOS format used for storing setups, waveforms, measurement results and hardcopy output.

Data formats: LeCroy Binary, ASCII, PSPICE®, MathCad®, Spreadsheet.

COMPUTER INTERFACES

Centronics® parallel standard: Hardcopy.

RS-232C standard: Remote control of modes, settings, and measurements; hardcopy.

GPIB IEEE 488.2 (optional): Fully programmable talk and listen modes; full remote control; hardcopy.

POWER REQUIREMENTS

Line voltage range: 90-135 V rms or 180-264 V rms auto-switched.

Frequency: 47 - 63Hz.

Battery Backup: Front-panel settings maintained for two years.

Power consumption: 430 Watts maximum.

PHYSICAL DESCRIPTION

Dimensions:

7 1/8" x 14 3/4 x 19".

Weight: 25.6 lbs. (base unit only, no options)

Operating Temperature: 5° C to 40° C.

Humidity: 95% noncondensing.

GPIB OPTION

HARDWARE SPECIFICATIONS

GPIB (IEEE-488.2) Compatible Interface Card. SCPI-compatible command set.

REMOTE CONTROL

GPIB port is configured as a Talker/Listener for computer control and fast data transfer. GPIB port is configured as a Talker Only for Hardcopy.

REMOTE HARDCOPY

Hardcopy to any of the ScopeStation supported printers and plotters that have a GPIB interface.

DATA TRANSFER

Formats: Bi-Directional Data transfer.

Maximum block transfer speed: 200 kbytes/sec.

GPIB UTILITY SOFTWARE

GTALK Software for IBM PC™ compatible computers with National Instruments® GPIB PC2, PC2A, or PC-AT GPIB Cards. This software utility sends and receives commands on the GPIB bus.

DISKETTE FORMAT

All software, drivers, and utilities supplied with the ScopeStation™ GPIB interface are provided on one 5 1/4" and one 3 1/2" DOS formatted floppy disk.

ETHERNET NETWORK OPTION

HARDWARE SPECIFICATIONS

Ethernet Interface Card configurable for 10Base5 (Thick Ethernet) or 10Base2 (Thin Ethernet) connections.

NETWORK REQUIREMENTS

Network server running Novell® Netware™ version 2.1X or 3.XX.

NETWORK HARDCOPY

Hardcopy to any of the ScopeStation™ supported printers and plotters over the network.

NETWORK STORAGE

Waveforms and panel setups can be stored to files on a network drive. Storage and hardcopy to a network drive are treated as if the network drive were an internal disk drive. The drive and directory can be specified for store or hardcopy-to-file operation.

Storage formats: Any ScopeStation™ supported format.

NETWORK RECALL

Waveforms and panel setups may be recalled from a network drive. During recall the network drive appears the same as an internal disk drive. The network drive and directory can be specified for the recall operation.

Recall formats: Any ScopeStation™ supported format, (waveform and setup data).

DISTRIBUTION DISKETTE FORMAT

All software supplied with the ScopeStation™-LS-NET interface is provided on 3 ½" DOS formatted floppy disks.

FAX OUTPUT OPTION SPECIFICATIONS

Provides the ability to directly fax a hardcopy of screen displays to a remote location.

Complies with Group 3 international facsimile standard. Communicates with any CCITT T.4/T.30, Group 3 compatible facsimile machine.

SCOPESTATION™ 140 INCLUDES

Three PP050 10x Scope Probes

One Front Cover

Operator's Manual

Power Cord

One Install Disk

2-Year Warranty

ORDERING INFORMATION

LS140	ScopeStation 140

INSTRUMENT OPTIONS

LS-FAX	Direct fax output
LS-NET	Ethernet interface
LS-GPIB	GPIB interface

OPTIONAL ACCESSORIES

LS-RM	Rackmount kit
LS140-OM	Operator's manual
LS140-SM	Service manual
LS-CART	Oscilloscope cart
LS-FC	Front cover
LS-TRANS	Transit case
LS-SOFT	Carrying bag
DC/GPIB	2 meter GPIB cable
PP050	10:1 probe
PP051	SMART Probe

LECROY LS140 DIGITAL OSCILLOSCOPE

Performance Verification Test

2.0 INTRODUCTION

This procedure can be used to verify the main operating specifications of the LeCroy LS140 digital oscilloscope. It is useful as a calibration verification procedure. A sample test record data sheet is provided at the end of this chapter.

EQUIPMENT REQUIRED		
DESCRIPTION	PERFORMANCE REQUIREMENTS	RECOMMENDED MODELS
Sine Wave Oscillator	Leveled amplitude output	TEK SG503
Digital Multimeter	Resistance measurement 1M with accuracy equal or better than 0.1%.	KEITHLEY 199
Highly accurate frequency reference generator	10 MHz accuracy equal or better than 0.001%. (10 ppm)	Marconi 2019A
50 feed-through terminator	BNC to BNC	LeCroy P/N 402 323 001
50 feed-through attenuator	BNC to BNC	
Coaxial cable to connect signal generators to UUT	50 Impedance 1m length BNC terminated	LeCroy P/N 480 020 101
Precision Power Supply	Overall Accuracy ≥ .1%	TEK PS5004

2.1 TURN ON

Switch on the power using the power switch on the front panel.

VERIFY:
- The display turns on after about 10 seconds.
- The display is stable.
- The range of intensity and grid intensity is reasonable.
- That during the initial calibration, verify there are no error messages in reverse video near the top edge of the display. Record status in Section 2.8.1.

2.2 INPUT IMPEDANCE

Make the following measurements with the digital multimeter.
Reset LS140 to defined state with RECALL, Setup, Scope Defaults, Yes.
For each channel 1, 2, 3, 4:

For each Volts/Div in the data sheet (Section 2.8.2):

Measure the resistance to the front panel ground point from the selected Channel's input connector for each coupling shown. Record results in Section 2.8.2.

2.3 BANDWIDTH

The purpose of this test is to ensure that the entire LS140 system has a bandwidth of at least 100 MHz at the probe tip. (70 MHz at 5 mv/div).

Set up a Tektronix SG503 leveled sine wave generator or equivalent.

- Frequency .5 MHz
- Amplitude 5V peak to peak

Terminate the output of the SG503 via a 50 Ohm feed through and connect it to the channel 1 input through a 10X-probe using the probe tip BNC Jack adapter.

Make sure the probe compensation is perfectly adjusted, low frequency.

- Gain : 1 v/div. (with X10 probe connected)
- Time/div. : 1 µs
- Measure : ON (Press Cursor/Measure)
- Set the SG503 output amplitude and the CH1 offset to provide a 5 divisions peak to peak sine wave as shown in Figure 2.3.

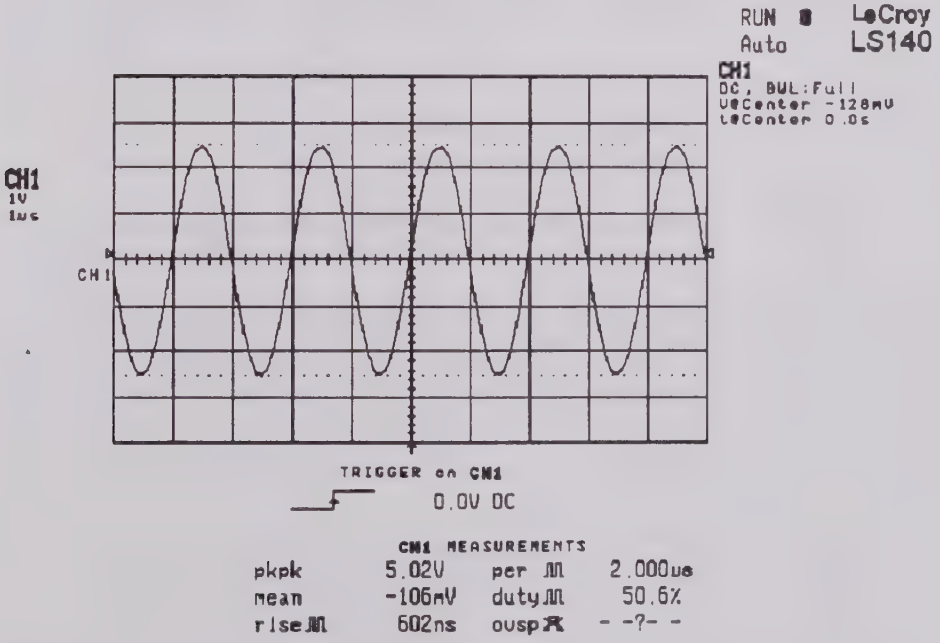


Figure 2.3 View of Scope Screen for Bandwidth Test

Increase the SG503 frequency, while decreasing the time/div. until the sine wave peak to peak amplitude is:

7 x 5 divisions = 3.5 divisions (3 dB point)

CHECK: – The frequency of the SG503 must be at least 100 MHz (70 MHz at 5 mv/div.). Record frequency in table 2.8.3.

Repeat the above test for input volts/div. of 50 mv, 20 mv, 10 mv, and 5 mv. Set the bandwidth limiter on, and check that the frequency at the 3 dB point is < 35 MHz.

Repeat all the tests for channel 2, channel 3, and channel 4.

2.4 MANUAL LINEARITY TEST

For a NIST calibration, follow the manual linearity test procedure using a calibrated and certified high precision voltage source, for example TEK PS5004.

Reset LS140 to defined state with RECALL,Setup,Scope Defaults,Yes.

SET SCOPE TO: Channel to be tested ON.

Time/div.	:	2 msec
Trigger source	:	Line
Measure	:	On

For each V/div. and for all channels separately, check the following: From the high precision source, apply the following 3 voltage values, one after another, to the channel to be tested:

1) 0
2) 3 * Volts/div setting on scope
3) 3 * Volts/div setting on scope

For example: if the volts/div setting on the scope is 2 V then the 3 voltage values would be 0, 6, and -6.

For each point, read off the 'Mean' parameter voltage and compare to the digital readout of the voltage reference. The difference of the two values in volts should be within 2% of full scale of the scope, depending on the sensitivity. Record results in Section 2.8.4.

2.5 TRIGGER ACCURACY

This test will verify the LS140's ability to trigger on a sine wave to an accuracy of ±2 minor divisions.

Reset LS140 to defined state with RECALL, Setup, Scope Defaults, Yes.

SET SCOPE TO: Timebase : 1 µS
Gain : 5 V/div.

Set the generator to 100 KHz output, set amplitude to get 8 divisions pk-pk, corresponding to a 4 v pk-pk amplitude.

VERIFY: – The sine wave must pass through the horizontal center of the screen (50% Pretrigger line) at the vertical position zero (vertical center) to within ± 2 minor divisions as shown in Figure 2.5A. Record results in Section 2.8.5.

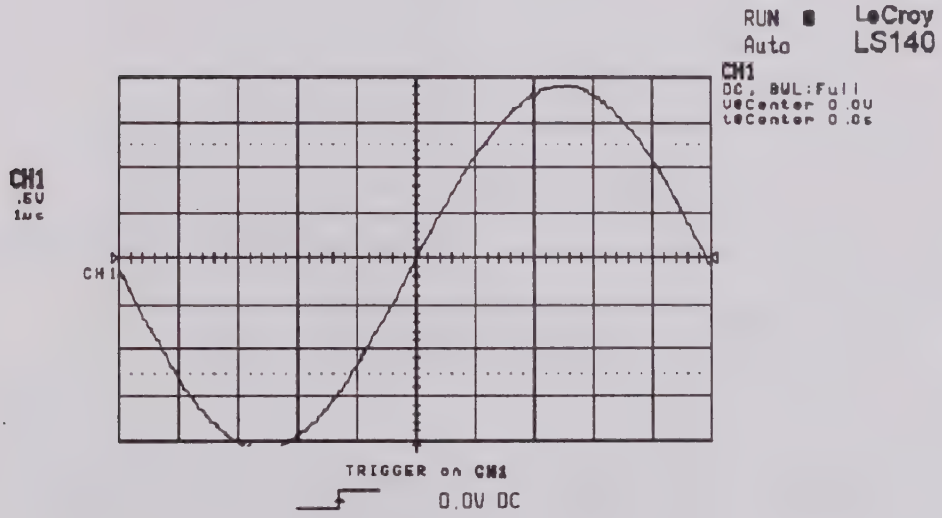


Figure 2.5A View of Scope Screen for Setup of Trigger Accuracy Test

Repeat for the following conditions:

- Trigger slope POS and NEG (verify slope at check point)
- Trigger coupling DC, DC BWL, AC .

Set the trigger level to + 1.5 V.

VERIFY: – The sine wave must pass the horizontal center at + 3 divisions within ±2 divisions as shown in Figure 2.5B. Record results in Section 2.8.5.

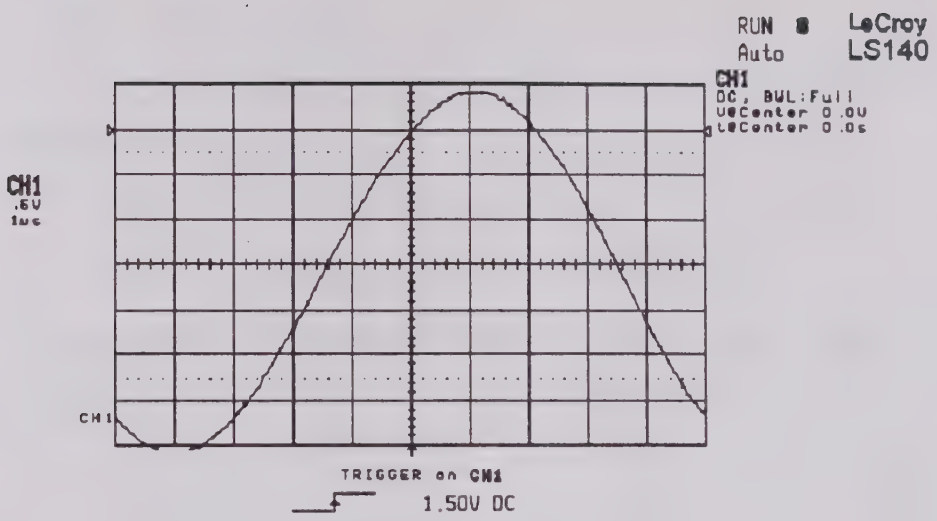


Figure 2.5B View of Scope Screen for Trigger Test

Repeat for the following conditions:

- Trigger slope POS and NEG (verify slope at check point).
- Trigger coupling DC, DC BWL, AC.

Set the trigger level to - 1.5 V.

VERIFY: - The sine wave must pass the horizontal center at -3 divisions within ±2 divisions. Record results in Section 2.8.5.

Repeat for the following conditions:

- Trigger slope POS and NEG (verify slope at check point).
- Trigger coupling DC, DCBWL, AC.

Repeat the above procedure for CH2, CH3 and CH4.

2.6 SMART TRIGGER

2.6.1 Trigger on Pulse Width >, <

Reset LS140 to defined state with RECALL, Setup, Scope Defaults, Yes.

SET SCOPE TO:			
	V/Div.	:	.5 V
	Timebase	:	20 nS
	Trigger		
	Type	:	Smart
	Smart type	:	Width < 10 ns

Set the generator to 55.0 MHz, amplitude to 3V pk-pk as shown in Figure 2.6A.

VERIFY: – The scope display is triggered. Record results in Section 2.8.6.

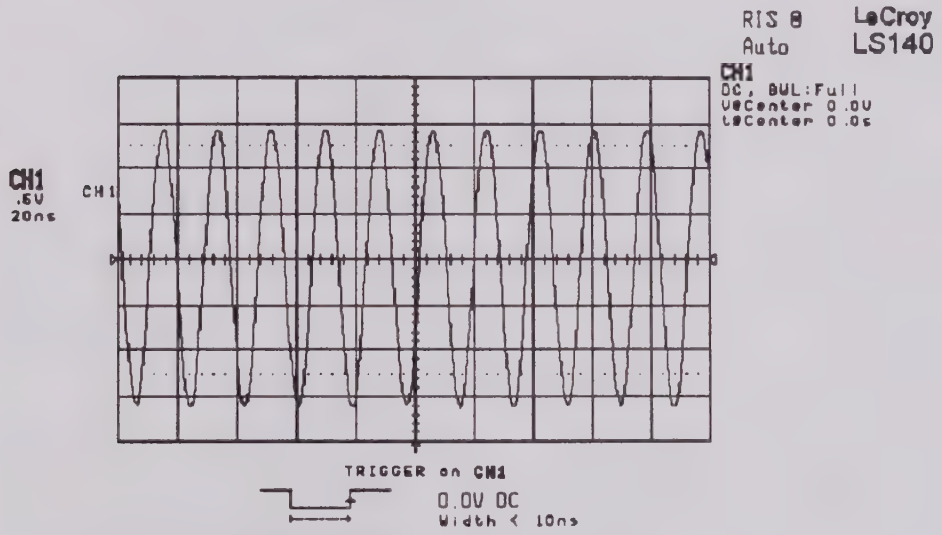


Figure 2.6A View of Scope Screen for Setup of Smart Trigger Test

SET SCOPE TO:			
	Trigger		
	Type	:	Smart
	Smart type	:	Width >10 ns

VERIFY: – The scope display does not have a stable trigger as shown in Figure 2.6B. Record results in Section 2.8.6.

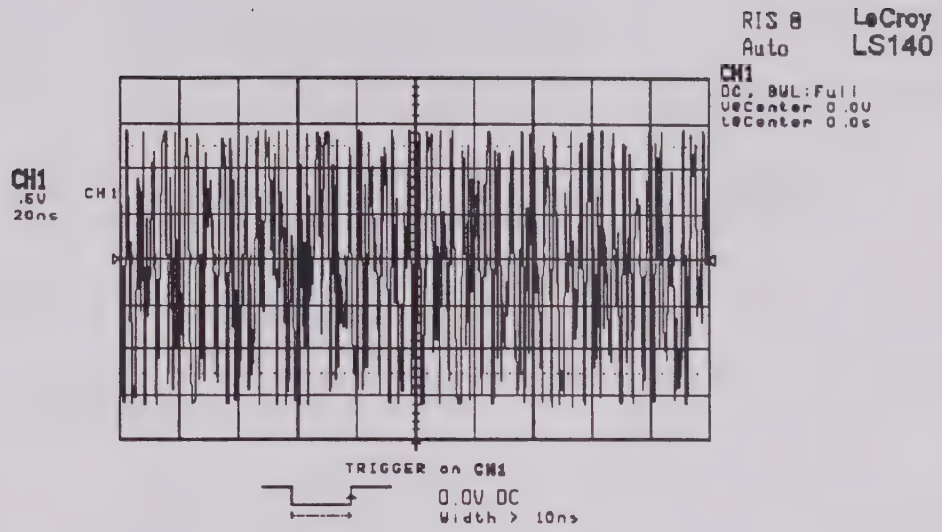


Figure 2.6B View of Scope Screen for an Unstable Trigger

2.6.2 Trigger on Interval Width >, <

Reset LS140 to defined state with RECALL, Setup, Scope Defaults, Yes.

SET SCOPE TO:			
	V/Div.	:	.5 V
	Timebase	:	20 nS
	Trigger		
	Type	:	Smart
	Smart type	:	Interval Width < 35 ns

Set the generator to 35.0 MHz, amplitude to 3V pk-pk.

VERIFY: – The scope display is triggered.

Set the generator to 25.0 MHz, amplitude to 3V pk-pk.

VERIFY: – The scope display is not triggered.

SET SCOPE TO:			
	Trigger		
	Type	:	Smart
	Smart type	:	Interval Width > 35 ns

VERIFY: – The scope display is triggered.

Set the generator to 35.0 MHz, amplitude to 3V pk-pk.

VERIFY: – The scope display is not triggered.Record all results in Section 2.8.6.

2.7 TIMEBASE ACCURACY

In order to verify the timebase, use a sine wave generator with a frequency accuracy of better than 10 ppm (for example, Marconi 2019A).

The following procedure describes a method to check the accuracy of the timebase clock.

Reset LS140 to defined state with RECALL, Setup, Scope Defaults, Yes.
Set the generator to 1.0002 MHz, amplitude to 10 dBm (4V pk-pk).

SET SCOPE TO:			
	Timebase	:	1 ms
	Measure	:	ON

Input 1.0002 MHz to channel 1 of LS140 and verify period is ≥ 3.33 ms and <10 ms as shown in Figure 2.7.

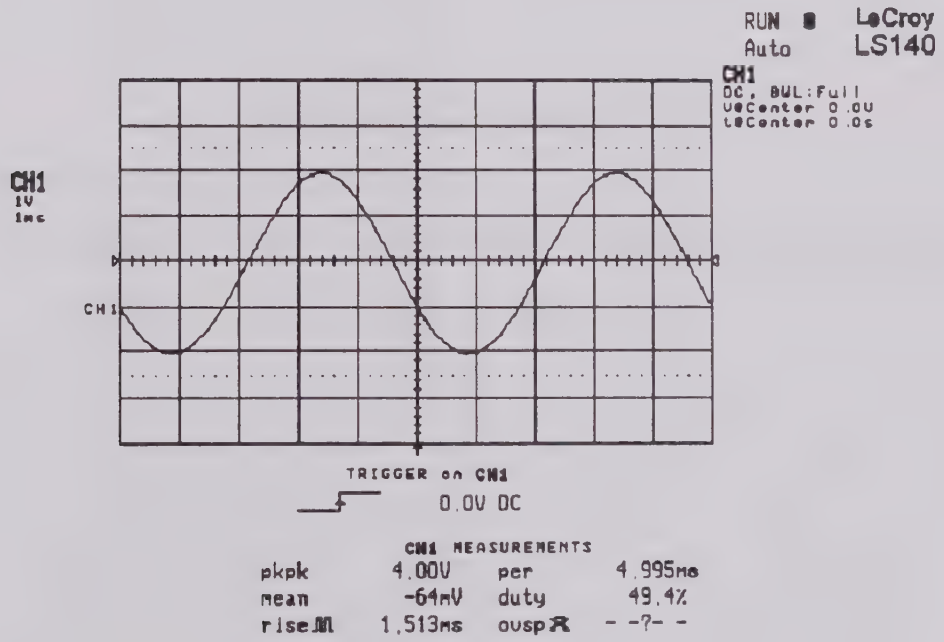


Figure 2.7 View of Scope Screen for Timebase Accuracy Test

2.8 LS140 PERFORMANCE VERIFICATION TEST RECORD

TESTED BY: _____ PASSED: _____ FAILED _____

SERIAL NUMBER*: _____ FIRMWARE REVISION*: _____

TEMPERATURE: _____ °C DATE _____

HUMIDITY:_____%

COMMENTS: _____

_____

_____

_____

_____

EQUIPMENT USED FOR CALIBRATION

INSTRUMENT	SERIAL NUMBER	CALIBRATION DUE DATE

*Press system config front panel button: The serial number and firmware revision details are shown on the bottom right of the display.

2.8.1 SELF CALIBRATION

Pass_____ Fail _____

2.8.2 Input Impedance

STEP	Ch	Volts/Div	Coupling	Lower	Upper	Reading	PASS	FAIL
2.2.1	1	.1	DC	0.99M	1.01M			
2.2.2	1	.1	GND	0.99M	1.01M			
2.2.3	1	1	DC	0.99M	1.01M			
2.2.4	1	1	GND	0.99M	1.01M			
2.2.5	1	10	DC	0.99M	1.01M			
2.2.6	1	10	GND	0.99M	1.01M			
2.2.7	2	.1	DC	0.99M	1.01M			
2.2.8	2	.1	GND	0.99M	1.01M			
2.2.9	2	1	DC	0.99M	1.01M			
2.2.10	2	1	GND	0.99M	1.01M			
2.2.11	2	10	DC	0.99M	1.01M			
2.2.12	2	10	GND	0.99M	1.01M			
2.2.13	3	.1	DC	0.99M	1.01M			
2.2.14	3	.1	GND	0.99M	1.01M			
2.2.15	3	1	DC	0.99M	1.01M			
2.2.16	3	1	GND	0.99M	1.01M			
2.2.17	3	10	DC	0.99M	1.01M			
2.2.18	3	10	GND	0.99M	1.01M			
2.2.19	4	.1	DC	0.99M	1.01M			
2.2.20	4	.1	GND	0.99M	1.01M			
2.2.21	4	1	DC	0.99M	1.01M			
2.2.22	4	1	GND	0.99M	1.01M			
2.2.23	4	10	DC	0.99M	1.01M			
2.2.24	4	10	GND	0.99M	1.01M			

2.8.3 BANDWIDTH

STEP	Ch	Volts/Div. (mv) w/ 10x probe	B/W Full		B/W 20 MHz				
			Lower Limit (MHz)	Reading (MHz)	Lower Limit (MHz)	Upper Limit (MHz)	Reading (MHz)	PASS	FAIL
2.3.1	1	1000	100						
2.3.2	1	500	100						
2.3.3	1	200	100						
2.3.4	1	100	100		16	27			
2.3.5	1	50	70						
2.3.6	2	1000	100						
2.3.7	2	500	100						
2.3.8	2	200	100						
2.3.9	2	100	100		16	27			
2.3.10	2	50	70						
2.3.11	3	1000	100						
2.3.12	3	500	100						
2.3.13	3	200	100						
2.3.14	3	100	100		16	27			
2.3.15	3	50	70						
2.3.16	4	1000	100						
2.3.17	4	500	100						
2.3.18	4	200	100						
2.3.19	4	100	100		16	27			
2.3.20	4	50	70						

2.8.4 Linearity

STEP	Ch.	Volts / Div.	X10 Atten & 50 feed through	Input Voltage	Limit	PASS	FAIL
2.4.1	1	5 mV	IN	±15 mV	±0.4 mV		
2.4.2	1	10 mV	IN	±30 mV	±0.8 mV		
2.4.3	1	20 mV	IN	±60 mV	±1.6 mV		
2.4.4	1	50 mV	IN	±150 mV	±4.0 mV		
2.4.5	1	.1 V	OUT	±300 mV	±8.0 mV		
2.4.6	1	.2 V	OUT	±600 mV	±16.0 mV		
2.4.7	1	2.0 V	OUT	±6.0 V	±160 mV		
2.4.8	2	5 mV	IN	±15 mV	±0.4 mV		
2.4.9	2	10 mV	IN	±30 mV	±0.8 mV		
2.4.10	2	20 mV	IN	±60 mV	±1.6 mV		
2.4.11	2	50 mV	IN	±150 mV	±4.0 mV		
2.4.12	2	.1 V	OUT	±300 mV	±8.0 mV		
2.4.13	2	.2 V	OUT	±600 mV	±16.0 mV		
2.4.14	2	2.0 V	OUT	±6.0 V	±160 mV		
2.4.15	3	5 mV	IN	±15 mV	±0.4 mV		
2.4.16	3	10 mV	IN	±30 mV	±0.8 mV		
2.4.17	3	20 mV	IN	±60 mV	±1.6 mV		
2.4.18	3	50 mV	IN	±150 mV	±4.0 mV		
2.4.19	3	.1 V	OUT	±300 mV	±8.0 mV		
2.4.20	3	.2 V	OUT	±600 mV	±16.0 mV		
2.4.21	3	2.0 V	OUT	±6.0 V	±160 mV		
2.4.22	4	5 mV	IN	±15 mV	±0.4 mV		
2.4.23	4	10 mV	IN	±30 mV	±0.8 mV		
2.4.24	4	20 mV	IN	±60 mV	±1.6 mV		
2.4.25	4	50 mV	IN	±150 mV	±4.0 mV		
2.4.26	4	.1 V	OUT	±300 mV	±8.0 mV		
2.4.27	4	.2 V	OUT	±600 mV	±16.0 mV		
2.4.28	4	2.0 V	OUT	±6.0 V	±160 mV		

2.8.5 TRIGGER ACCURACY

STEP	Ch.	Trig Level	Slope	PASS	FAIL
2.5.2	1	0	NEG		
2.5.3	1	+1.50 V	POS		
2.5.4	1	+1.50 V	NEG		
2.5.5	1	- 1.50 V	POS		
2.5.6	1	- 1.50 V	NEG		
2.5.7	2	0	POS		
2.5.8	2	0	NEG		
2.5.9	2	+1.50 V	POS		
2.5.10	2	+1.50 V	NEG		
2.5.11	2	- 1.50 V	POS		
2.5.12	2	- 1.50 V	NEG		
2.5.13	3	0	POS		
2.5.14	3	0	NEG		
2.5.15	3	+1.50 V	POS		
2.5.16	3	+1.50 V	NEG		
2.5.17	3	- 1.50 V	POS		
2.5.18	3	- 1.50 V	NEG		
2.5.19	4	0	POS		
2.5.20	4	0	NEG		
2.5.21	4	+1.50 V	POS		
2.5.22	4	+1.50 V	NEG		
2.5.23	4	- 1.50 V	POS		
2.5.24	4	- 1.50 V	NEG		

2.8.6 Smart Trigger

STEP	Ch.	Trig Type	Input Freq	Triggered	PASS	FAIL
2.6.1	1	width <	55 MHz	YES		
2.6.2	1	width >	55 MHz	NO		
2.6.3	1	interval <	35 MHz	YES		
2.6.4	1	interval <	25 MHz	NO		
2.6.5	1	interval >	25 MHz	YES		
2.6.6	1	interval >	35 MHz	NO		

2.8.7 TIMEBASE ACCURACY

STEP	Ch.	Lower Limit	Upper Limit	PASS	FAIL
2.7.1	1	3.33 mS	10.0 mS		

ADJUSTMENTS

3.0 INTRODUCTION

This section includes the adjustments required for the instrument. The CRT and auxiliary power supply adjustments should only be needed if the assembly is replaced. It is recommended that adjustments for the acquisition board (724-F-1) be verified at one year intervals.

> NOTE: IF IT IS NOT POSSIBLE TO MAKE ANY OF THE FOLLOWING ADJUSTMENTS, REFER TO THE TROUBLESHOOTING SECTION OF THIS MANUAL.

3.1 CRT & VIDEO ADJUSTMENTS

3.1.1 Equipment

1. Non-conductive tuning tool (1/8" flat blade on one end and .100" Hex on the other).

3.1.2 Set-Up

1. Allow the unit to warm-up for approximately 5 minutes.
2. Refer to FIG. 3.1 for the location of the adjust pots.
3. If the screen is scrolling vertically adjust the VERT. HOLD
4. Display the monitor test pattern by doing the following:
   a) Press MENU RETURN, CHANNEL 1, and AUTO SETUP front panel keys simultaneously
   b) Select Display Test (Top blue screen menu key)
   c) Select Test Pattern (Top blue screen menu key)
   d) The Display Test Pattern should be displayed (See FIG 3.1A)

3.1.3 Rough Adjustments

1. Rough adjustments should be made before attempting to truly adjust the display. These adjustments may, or may not, be necessary depending on the original adjustment of the monitor.
2. Adjust the HORIZ. CENTER so that the eight arrows on the right hand side of the test pattern are fully visible.
3. Adjust the HORIZ. WIDTH so that the left side of the outer most box is visible.
4. Adjust the VERT. SIZE so that the top and bottom lines of the outermost box of the test pattern are just visible.

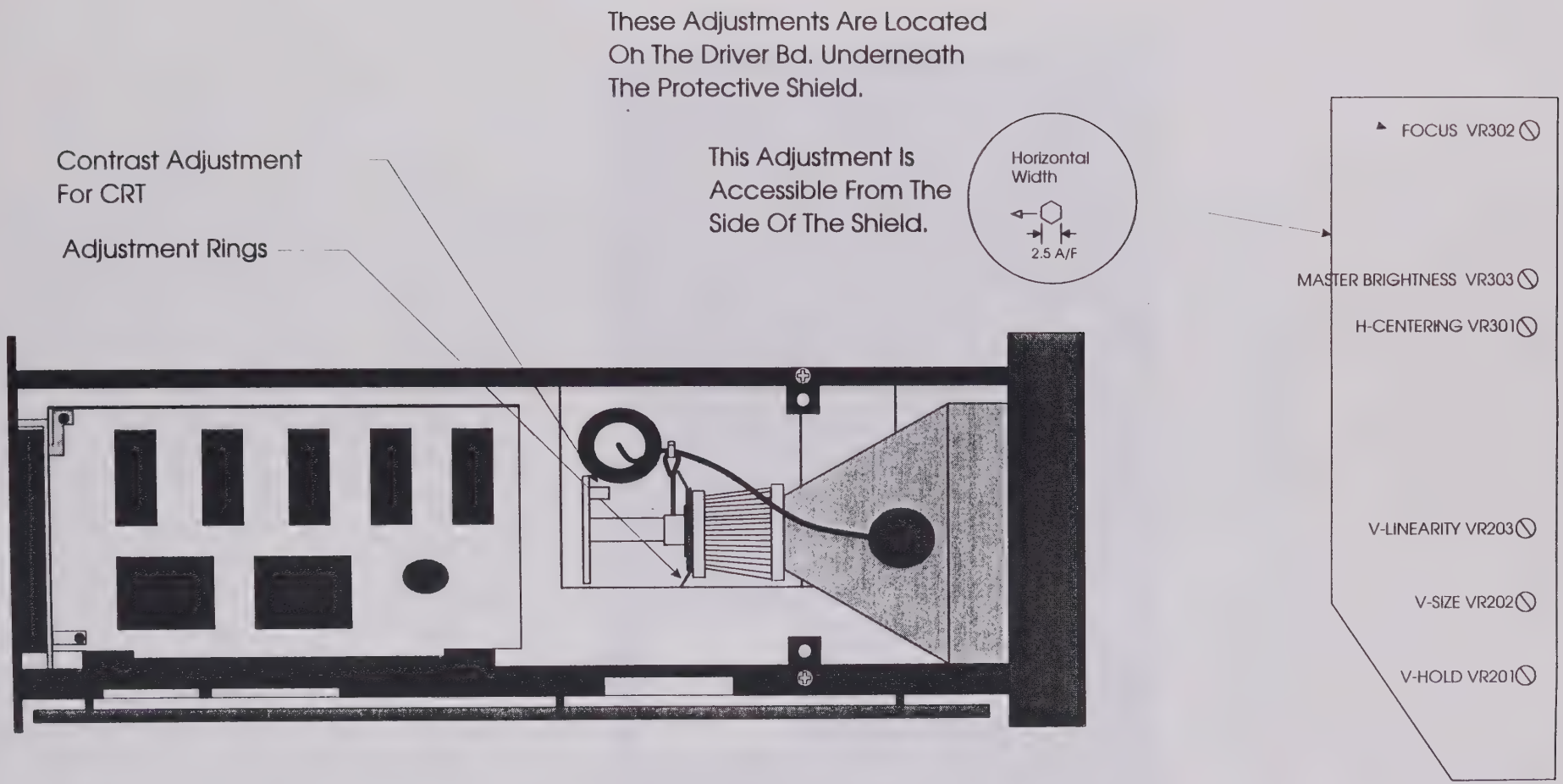


FIG. 3.1 CRT
ADJUSTMENTS

Display Test Pattern

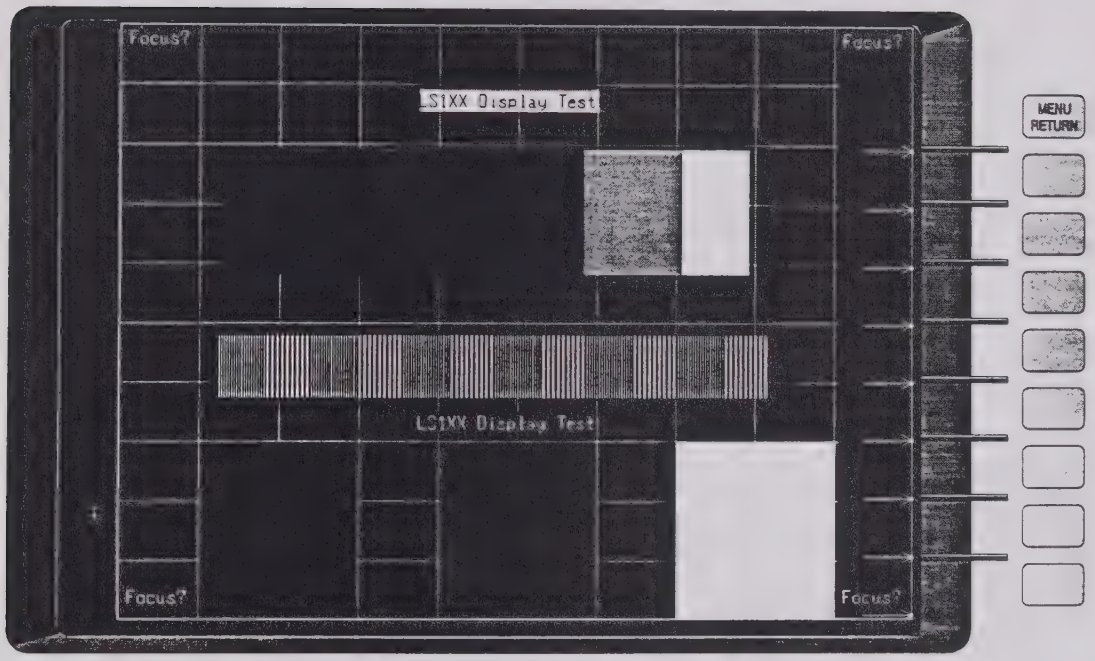


FIG 3.1A CRT &
Video Adjustments

Screen Menu For Channel 1

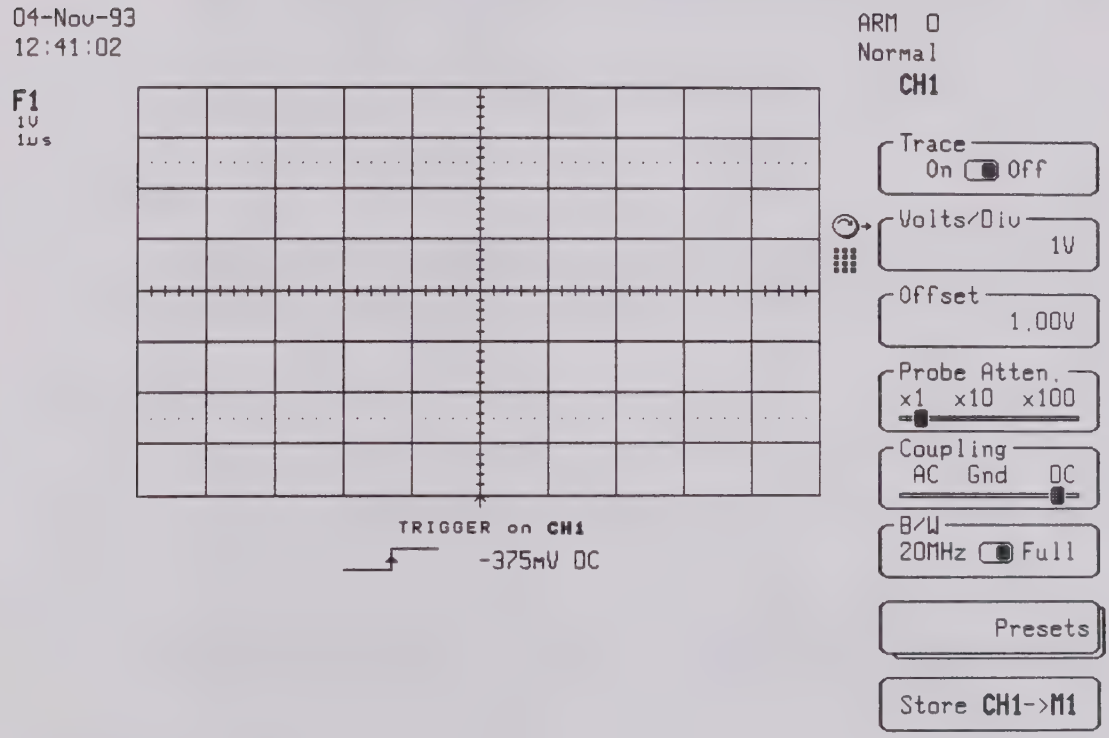


Fig. 3.1B
CRT & Video Adjustments

3.1.4 Vertical Linearity

1. Adjust the VERT. LIN. so that the height of the top row of boxes in the test pattern are the same height as the bottom row. This can be easily done by using a measurement tool such as a ruler to compare the height of the bottom and top row of boxes.

3.1.5 Vertical Size And Alignment

1. This alignment requires the adjustment of three parts simultaneously.
2. Break the sealant on the metal adjustment rings located on the neck of the CRT tube, connected to the rear of the yoke.
3. Adjust the VERT. SIZE and the CRT adjustment rings simultaneously to align the eight arrows on the right of the test pattern with the eight embossed grooves in the front panel viewport.
4. Reseal adjustments rings after the adjustment is correct. Use torque seal or similar product.

3.1.6 Focus

1. Adjust the FOCUS for best overall clarity of the lower block of vertical lines just above the "LS1XX Display Test" text. Adjust the finer lines to the point at which they start to appear somewhat dotted.

3.1.7 Horizontal Centering And Size

1. Adjust the HORIZ. CENTER to center the display horizontally.
2. Adjust the HORIZ. WIDTH until the left and right side of the outermost lines of the test pattern are 1/8 of an inch from the sides.
3. Adjust the HORIZ. CENTER so that the right line of the outermost box is as far to the right as possible but still fully visible by looking straight on at the display. The end result should be a 1/4" inch gap between the left side of the opening in the casting and the left outermost line of the test pattern.

3.1.8 Vertical Hold

1. While in the test pattern, press the CHANNEL 1 button on the front panel key pad.
2. Adjust the VERT. HOLD clockwise until the display begins to roll and note the position of the pot.
3. Adjust the VERT. HOLD counterclockwise until the display is stable.
4. Adjust the VERT. HOLD counterclockwise until the display begins to roll. and note the position of the pot.
5. Adjust the VERT. HOLD to the midpoint between the two points at which the display began to roll.

3.1.9 Brightness And Contrast

1. Press the CHANNEL 1 button on the front panel keypad until the Channel 1 screen menu appears. (See FIG 3.1B)
2. Adjust the CONTRAST as high (i.e. bright) as possible without causing the text in the menus to become blurred. The best place to check is between the M and H in 20MHz located in the third screen menu selection from the bottom. The two letters should be sharp and not blurred.
3. Adjust the MASTER BRIGHTNESS until the active part of the display area just starts to have an orange glow.
4. Lower the MASTER BRIGHTNESS until the active area of the display is as black as the border background. It should be no brighter or darker than the border.

3.2 AUXILIARY POWER SUPPLY ADJUSTMENT (-5.2V 50W)

3.2.1 Equipment

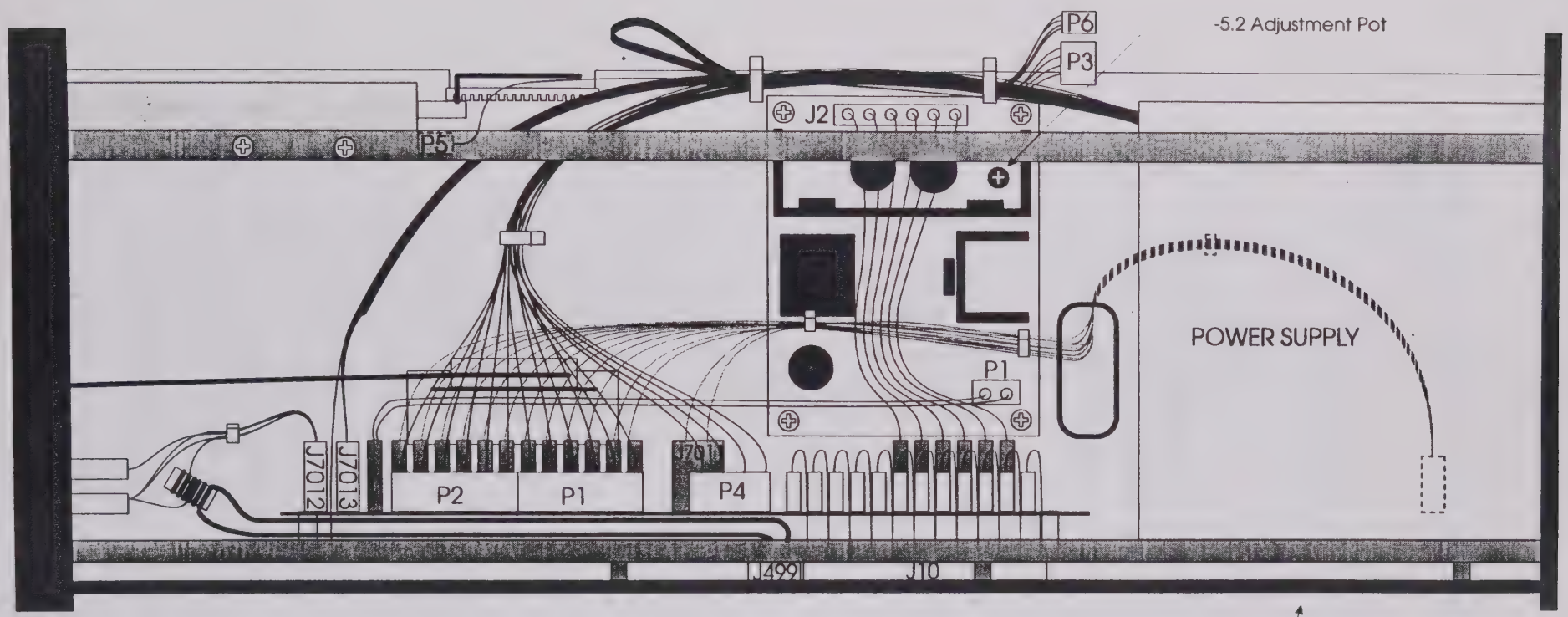
1. Voltmeter
2. Flat Head Screwdriver with 1/4" Head

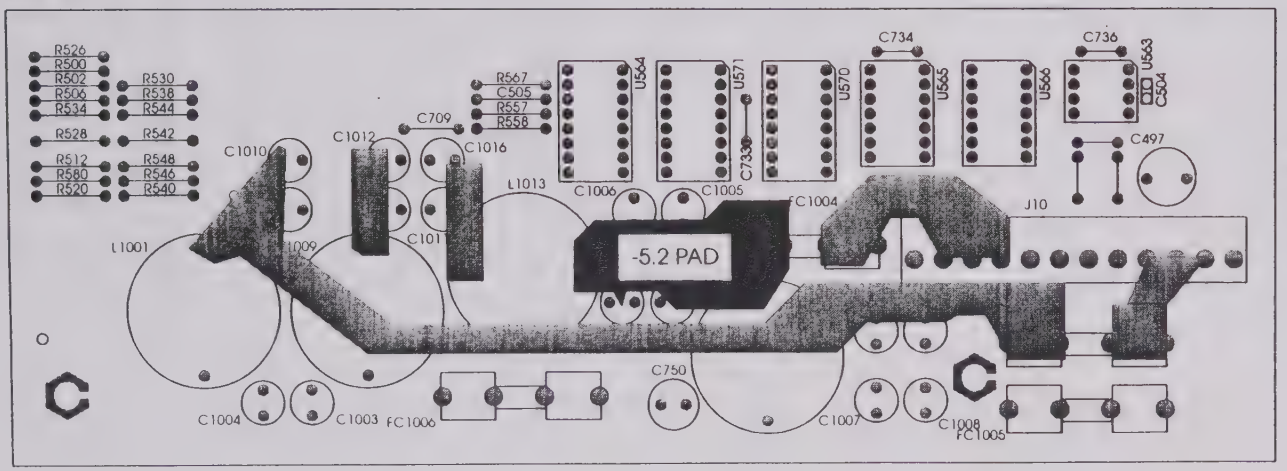
3.2.2 Set-Up

1. Place the unit on its side so that the auxiliary power supply is facing up.
2. Allow the unit to warm up for three minutes.
3. Connect the negative lead of the voltmeter to chassis.
4. Connect the positive lead of the voltmeter to the large silver pad located just to the left of U571 as shown in Fig. 3.2.

3.2.3 Adjustment

1. Adjust the black pot on the power supply just above the heat sink on the right hand side as shown in Fig. 3.2 until the voltmeter reads -5.2 Vdc ±1%.





VIEW OF UNDERSIDE
OF 724-F-1 BD.
DARK PATCH INDICATES
PLACEMENT OF PROBE.

FIG 3.2 AC\DC
P.S. ADJUSTMENT

3.3 ACQUISITION BOARD (724-F-1) FRONT END ADJUSTMENTS

3.3.1 Equipment

1. Pulse Generator (5V.amp., Flatness ≤.5%, Settles to ≤.5% in ≤1μs)
2. 50W Feedthru BNC Terminator
3. X10 Attenuator
4. Coax Cable To Connect Pulse Generator To BNC Terminator
5. Flat non-conductive blade adjustment tool (2mm)
6. Hex non-conductive adjustment tool (Johanson 4192)
7. LS140 Supplementary Disk (located in the back of the Service Manual)

3.3.2 Set-Up 1

1. Set up the Pulse Generator as follows:
   a) AMPLITUDE 5V
   b) BASE -200mV
   c) DUTY CYCLE 50%
   d) LEAD 1ns
   e) TRAIL 1ns
   f) FREQUENCY 100Hz
2. Power up the LS140 for 10 minutes.
3. Remove the cabinet of the LS140 (Sect. 5.1)
4. Place the unit on its side so that the power wiring and auxilary power supply are facing up as in Fig. 3.2.
5. Replug in and power-up unit.
6. Connect the output of the pulse generator to the input of Channel 1 of the LS140 through a 50W terminator.
7. Place the supplementary disk, contained in the rear of the service manual, into the floppy of the LS140. This disk contians saved setups for each step of this procedure.
8. Press the RECALL key located just to the left of the floppy drive.
9. Select SETUP from the blue screen keys (Second blue key from the top).
10. Select SCOPE SETTINGS from the blue screen keys (Top blue key).
11. SOURCE should be set to FLOPPY.
12. Select SELECT FILE from the blue screen keys (Third blue key from the bottom).
13. Turn the large front panel control knob until the file SETUP000.PNL.

724-F-1 PC Board
(Solder Side - Front End Only)

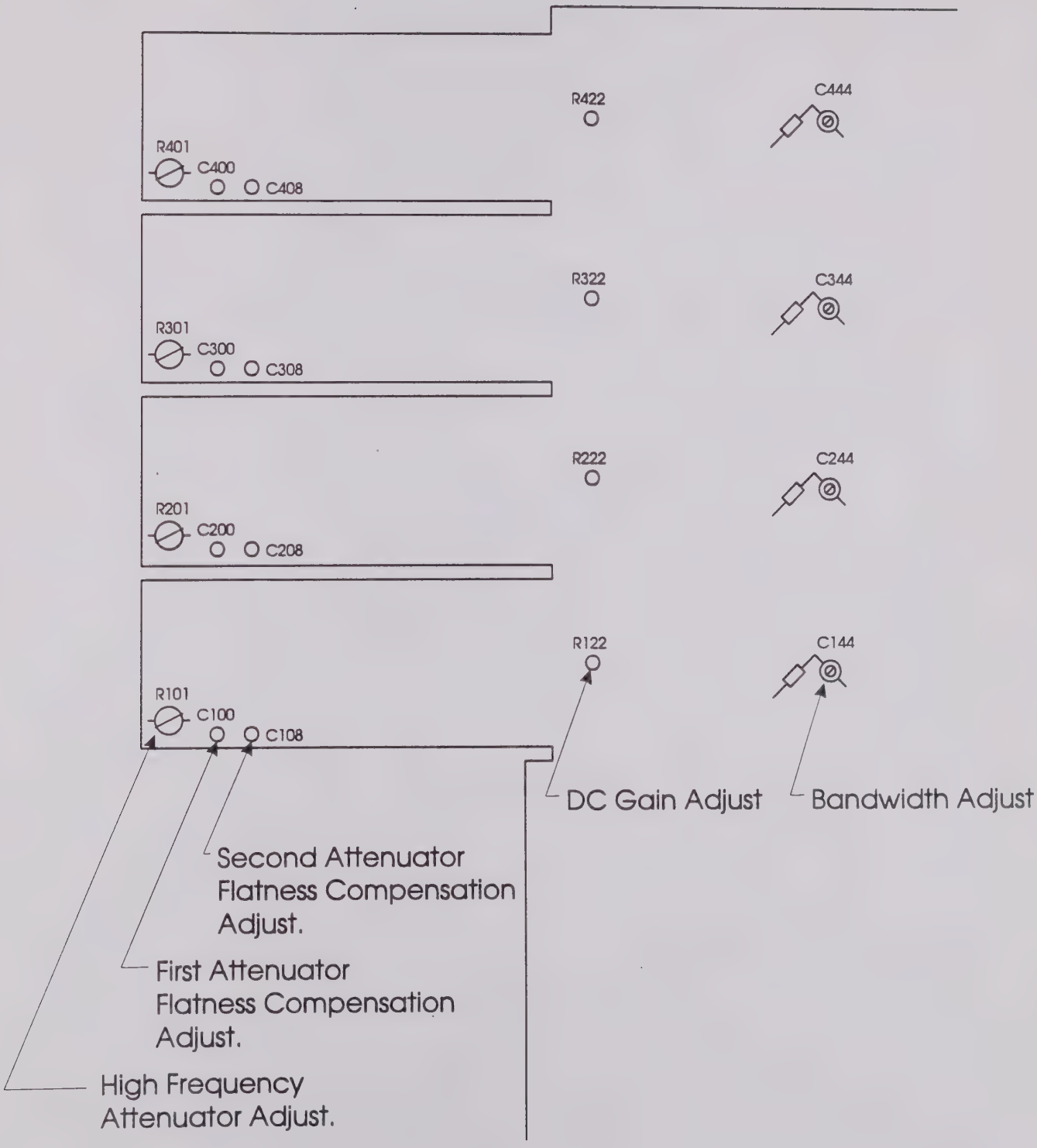


FIG 3.3 724-F-1
Front End Adjustments

724-F-1 FRONT END ADJUSTMENT DISPLAYS

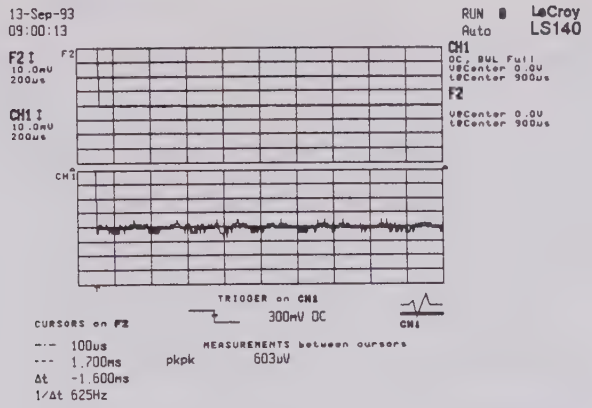


FIG. 3.3A
DC GAIN, FIRST & SECOND ATTENUATOR ADJUSTMENT

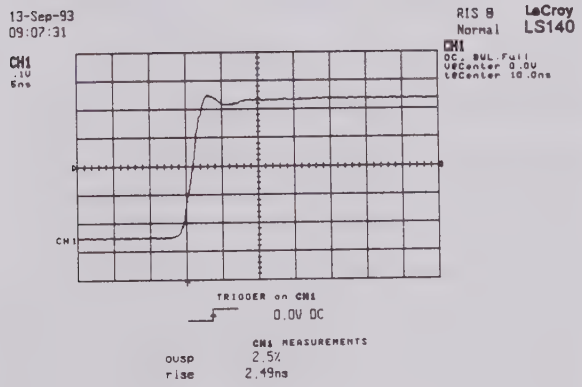


FIG. 3.3B
BANDWIDTH ADJUST

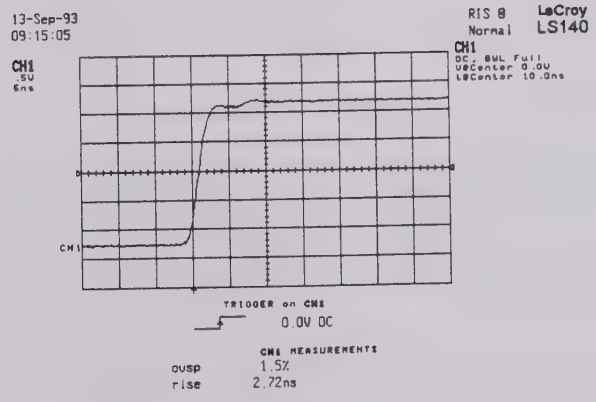


FIG. 3.3C
HIGH FREQUENCY ATTENUATOR ADJUST

3.3.2 Set-Up 1 (continued)

14. Switch AUTO INCR. to YES by selecting it from the blue screen keys (Second from the bottom).
15. Select EXECUTE from the blue screen menu keys (Bottom blue key).
16. The scope will automatically setup all of the parameters for the adjustment.
17. Adjust R122 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 600uV to 1.2mV.
18. Select EXECUTE from the blue screen menu keys (Bottom blue key).
19. Adjust C100 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 10mV to 20mV.
20. Select EXECUTE from the blue screen menu keys (Bottom blue key).
21. Adjust C108 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 15mV to 30mV.
22. Remove the signal from Channel 1 and connect it to Channel 2.
23. Select EXECUTE from the blue screen menu keys (Bottom blue key).
24. Adjust R222 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 600uV to 1.2mV.
25. Select EXECUTE from the blue screen menu keys (Bottom blue key).
26. Adjust C200 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 10mV to 20mV.
27. Select EXECUTE from the blue screen menu keys (Bottom blue key).
28. Adjust C208 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 15mV to 30mV.
29. Select EXECUTE from the blue screen menu keys (Bottom blue key).
30. Adjust R322 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 600uV to 1.2mV.
31. Select EXECUTE from the blue screen menu keys (Bottom blue key).
32. Adjust C300 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 10mV to 20mV.
33. Select EXECUTE from the blue screen menu keys (Bottom blue key).

3.3.2 Set-Up 1 (continued)

34. Adjust C308 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 15mV to 30mV.
35. Select EXECUTE from the blue screen menu keys (Bottom blue key).
36. Adjust R422 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 600uV to 1.2mV.
37. Select EXECUTE from the blue screen menu keys (Bottom blue key).
38. Adjust C400 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 10mV to 20mV.
39. Select EXECUTE from the blue screen menu keys (Bottom blue key).
40. Adjust C408 (As shown in Fig. 3.3) until the displayed measurement of peak to peak voltage (pkpk) is as close to zero as you can adjust it as shown in Fig. 3.3A. Typical numbers are 15mV to 30mV.

3.3.3 Set-Up 2

1. Set up the Pulse Generator as follows:

a) AMPLITUDE	5V
b) BASE	-2.5V
c) DUTY CYCLE	50%
d) LEAD	1ns
e) TRAIL	1ns
f) FREQUENCY	1MHz

2. Insert a X10 attenuator between the 50W terminator and the coax cable connected to the pulse generator.
3. Connect the signal thru the 50W terminator and X10 attenuator to Channel 1 of the LS140.
4. Select EXECUTE from the blue screen menu keys (Bottom blue key).
5. Adjust C144 (As shown in Fig. 3.3) until the displayed measurement of overshoot (ovsp) is 2.0 to 3.0% and the rise time (rise) is as less than 3 ns. as shown in Fig. 3.3B.
6. Remove the signal from Channel 1 and connect it to Channel 2.
7. Select EXECUTE from the blue screen menu keys (Bottom blue key).
8. Adjust C244 (As shown in Fig. 3.3) until the displayed measurement of overshoot (ovsp) is 2.0 to 3.0% and the rise time (rise) is as less than 3 ns. as shown in Fig. 3.3B.
9. Remove the signal from Channel 2 and connect it to Channel 3.

3.3.3 Set-Up 2 (continued)

10. Select EXECUTE from the blue screen menu keys (Bottom blue key).
11. Adjust C344 (As shown in Fig. 3.3) until the displayed measurement of overshoot .(ovsp) is 2.0 to 3.0% and the rise time (rise) is as less than 3 ns. as shown in Fig. 3.3B.
12. Remove the signal from Channel 3 and connect it to Channel 4.
13. Select EXECUTE from the blue screen menu keys (Bottom blue key).
14. Adjust C444 (As shown in Fig. 3.3) until the displayed measurement of overshoot (ovsp) is 2.0 to 3.0% and the rise time (rise) is as less than 3 ns. as shown in Fig. 3.3B.

3.3.4 Set-Up 3

1. Set up the Pulse Generator as follows:
   a) AMPLITUDE 2.5V
   b) BASE -1.25V
   c) DUTY CYCLE 50%
   d) LEAD 1ns
   e) TRAIL 1ns
   f) FREQUENCY 1MHz
2. Connect the signal thru the 50W terminator to Channel 1 of the LS140.
3. Select EXECUTE from the blue screen menu keys (Bottom blue key).
4. Adjust R101 (As shown in Fig. 3.3) until the displayed measurement of overshoot (ovsp) is 1.5% and the rise time (rise) is as less than 3 ns. as shown in Fig. 3.3C.
5. Remove the signal from Channel 1 and connect it to Channel 2.
6. Select EXECUTE from the blue screen menu keys (Bottom blue key).
7. Adjust R201 (As shown in Fig. 3.3) until the displayed measurement of overshoot (ovsp) is 1.5% and the rise time (rise) is as less than 3 ns. as shown in Fig. 3.3C.
8. Remove the signal from Channel 2 and connect it to Channel 3.
9. Select EXECUTE from the blue screen menu keys (Bottom blue key).
10. Adjust R301 (As shown in Fig. 3.3) until the displayed measurement of overshoot (ovsp) is 1.5% and the rise time (rise) is as less than 3 ns. as shown in Fig. 3.3C.
11. Remove the signal from Channel 3 and connect it to Channel 4.
12. Select EXECUTE from the blue screen menu keys (Bottom blue key).
13. Adjust R401 (As shown in Fig. 3.3) until the displayed measurement of overshoot (ovsp) is 1.5% and the rise time (rise) is as less than 3 ns. as shown in Fig. 3.3C.

LS140 BASIC OPERATION

4.0 GENERAL DESCRIPTION

The LeCroy LS140 Digital Oscilloscope combines the signal acquisition capabilities of a four channel 100MHz analog bandwidth with dual 200MS/s digitizing system. Powerful trigger capabilities and a 2,000 point record length enhance the signal analysis system. Signals and configuration data are handled by a powerful 32 bit processor system. Connectivity features add considerable power to the application of the oscilloscope by linking the processor system to the computing and telecommunications environment using industry standard interfaces. Refer to figure 4.0 when reading about the various parts of the LS140 system.

4.1 LS140 MAIN BOARD (ASSEMBLY 724-F-1)

4.1.1 General

The LS140 main board is the heart of the entire system. All of the analog processing, trigger processing and timebase are contained on the 724-F-1 board. The digital representation of the analog signal is sent to the processor section for interpretation and analysis.

4.1.2 Front End

Reference Schematics: (See Section 7)

CTFG1_1.SCH, SCTFG1_2.SCH	(Channel 1 attenuator and gain stages)
MUX1.SCH	(ADC 1 vertical mux.)
MUX.SCH	(Trigger mux.)
DADX1.SCH	(ADC 1)
DCREF.SCH	(ADC references)
DACREF.SCH	(Control DACs)
SCTFECTL.SCH	(Control registers)

For the LS140, channels one through four can be assumed to be identical, so we will only discuss channel one.

4.1.2.1 Basic Structure

Refer to Fig.4.1. Input signals are routed through two switched divide-by-ten high impedance attenuators, and are connected to the unity gain buffer stage. This presents a high input impedance, low capacitance load to the input, and accepts the offset and calibration inputs. The following two amplifiers are configured as gain switched op. amps., with built-in overload protection. Two outputs are provided; one for the trigger via TMUX, and one to the ADC via VMUX.

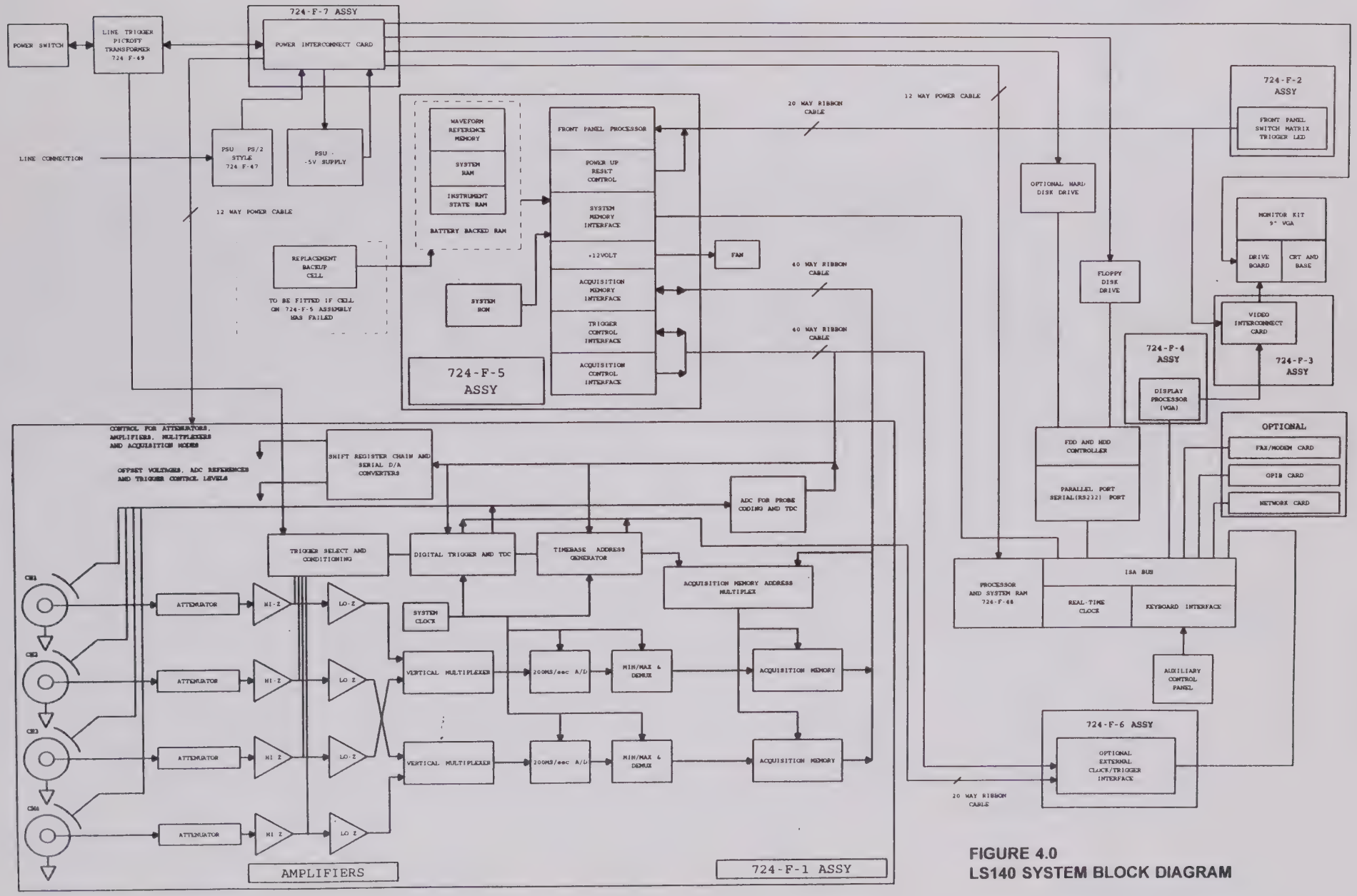


FIGURE 4.0
LS140 SYSTEM BLOCK DIAGRAM

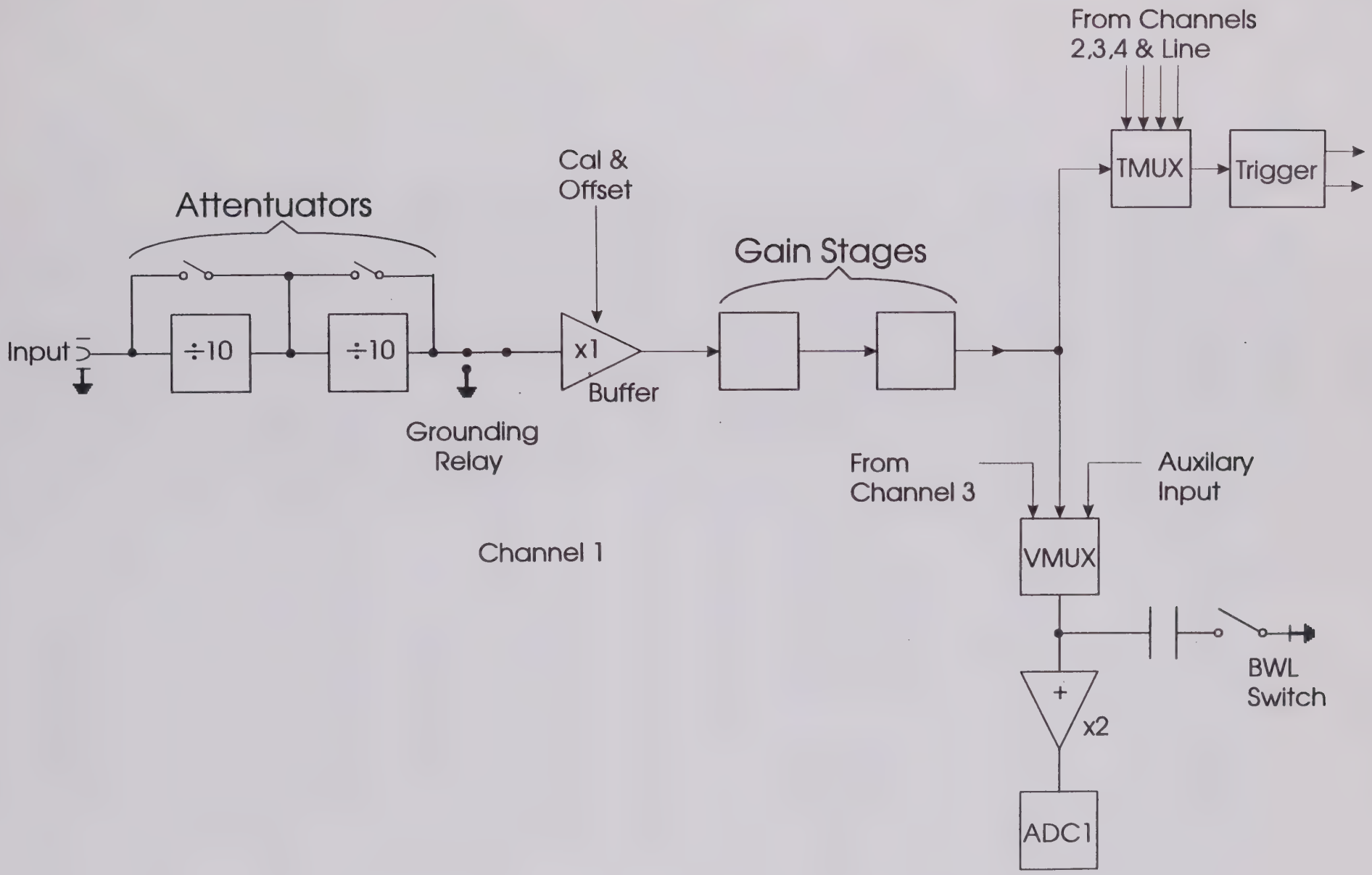


FIG 4.1 FRNT
END BLK. DIAG.

4.1.2.1 Basic Structure (continued)

The VMUX circuits route the conditioned signals to the ADCs. If four channels are in use, then first channels 1 and 2 are digitized via ADCs 1 and 2 respectively, and then channels 3 and 4 are digitized via ADCs 1 and 2. Each ADC is preceded by a gain of two; full bandwidth/bandwidth limit is selected at the mux. output. Two auxiliary inputs to the muxes are provided; they are for possible future expansion and are not currently used in the LS140.

The control and calibration system generates all switching, multiplexing, offset and calibration signals for the front end. Offset and calibration are done via dual stereo audio dacs in conjunction with a precise voltage reference. ADC references and trigger analog control signals are generated by an octal dac.

4.1.2.2 Input Attenuators And Buffer

Refer to Channel 1 Input Stage schematic (SCTFG1_1.SCH). The input signal is routed to the high impedance buffer (Q104 and associated components) via two divide-by-ten high impedance attenuators (K100, K101 and associated components) and the grounding relay K102. Both attenuators are similar; in the attenuator around K100, the resistive signal attenuator is formed by R102 and R104. With the relay in the de-energised state (as shown on the schematic) the signal is attenuated by a factor ten via R102 and R104. High frequency
compensation maintains wide input bandwidth and constant input capacitance. C100 adjusts the attenuator compensation for flat frequency response.

The second attenuator is similar, with C108 providing the flatness adjustment. K102 grounds the input to the buffer and disconnects the input signal when the 'Input Coupling' is set to 'Ground'.

The signal is routed via the grounding relay to both the high impedance buffer and its associated DC amplifier, consisting of U100A&B, Q102 and Q103. The high impedance buffer consists of a self-biased FET, Q104, and a wideband amplifier U101. This buffer has two signal paths; the AC path is via C110 to Q104, and the DC path via R110, which also defines the DC input resistance (1 Megohm), to U100A. DC feedback from U101 output to U100B input ensures correct biasing of Q104: potentiometer R122 is used to match the DC gain to the AC gain (the AC gain is fixed to near unity by source follower Q104 and unity gain buffer U101).

U100B is configured as a virtual ground DC amplifier with a gain of approximately -0.04 (approx. the ratio of R111 to R110). Q109 and Q110 are low distortion clamps around U100A. When the 'Input Coupling' is set to 'DC', Q100 is 'on' and connects the output of U100A to the input of U100B via R112. Since R111 and R112 are the same value, the input current to U100B is the same as the input current flowing in R110.

4.1.2.2 Input Attenuators And Buffer (continued)

This signal current flows in the virtual ground of U100B, and is summed at this point with the offset current defined by 'CH1 Offset' voltage and R125. Since R110, R111, R112 and R125 are precision resistors, a DC level at the input node can be precisely offset to zero via an identical DC level at the 'CH1 Offset' node. (This is also true when the two attenuators are switched in, because the attenuator resistors also have precise values). This configuration has the advantage of providing high offset voltage even on the most sensistive input ranges.

When the 'Input Coupling' is set to 'AC', Q100 is turned 'off', thus breaking the DC path to U100B, and Q101 is turned 'on'; this action slows down the response of the loop around U100B, Q102, Q103 and U101 and produces a high pass response with a -3dB point at <10Hz.

Input protection is provided by VR100; this is a spark gap with a breakdown voltage fractionally higher than the maximum rated input voltage (400V). The probe sense circuit is protected via varistor RV103.

4.1.2.3 Gain Stages

Refer to SCTFG1_2.SCH. The gain required in the amplifier is provided by two fast current input amplifiers, U102 and U103 and associated components. The output from the high impedance buffer passes to two transistor switches; Q105 and Q106. These are used as saturated switches and provide low `on' resistance and low offset voltage. The state of these two switches is defined on the schematic as a function of the volts/division selected. Q111 is used to increase the `off' isolation of Q106; any high frequency `blow-by' is shunted to ground via Q111. R128 and R129, in conjunction with R134 (the feedback resistor around U102) determine the gain of the first stage.

The output of the first stage, at pin 6 of U102, is applied to two further switches, Q107 and Q108; then via R135, R136 to U103. As in the first stage, the selected gain is defined by R137, R135 and R136; the switch state is related to the selected volts/division on the schematic.

The output of U103 drives the VMUX (vertical multiplexer) via R140 (which drives and terminates the microstrip line on the PCB); it also drives the transmission line to the TMUX (trigger multiplexer) via attenuator R138 and R139. The TMUX input level is nominally 200mV pk-pk.

4.1.2.4 Vertical Multiplexer (VMUX)

See VMUX1.SCH. VMUX1 routes signals from CH1 and CH3 gain stages to ADC1 input. R177 and R179 terminate the transmission lines from the two gain stages. Q189 and Q191 select either CH1 or CH3; Q170 (unused in the basic LS140) allows connection of an auxiliary input to ADC1.

Q193 is used to activate the 20 MHz bandwidth limit, defined by C194, and again is a simple saturated switch. U170 is the ADC driver, with fixed gain of two. Nominal swing at the ADC input is ±0.5volts.

4.1.2.5 Control, Offset And Calibration

A) Control

See SCTFECTL.SCH. The control and calibration circuits are all linked to the processor via a serial chain. U12 and U13 are used as level shifters to convert 5 volt CMOS logic swings to ±5 volt swings used in the control chain. U14 and U15 are each 32 bit registers with output levels of approximately +10.5 volts and -5 volts. These outputs are used for all the relays and solid state switches in the signal conditioning and trigger circuits. U16F shifts the serial data output (SDO) level at U15 output back to 5 volt logic in order to correctly drive the offset DACs.

B) Offset And Calibration

See DACREF.SCH. Each channel has a dedicated offset DAC (U4A&B and U3A&B). Each of these 16 bit DACs drives a conditioner (U5 A,B,C and D) which provides ±1.2 volts full scale output. Each of these outputs passes via a multiplexer (U8, U7) to the appropriate offset node in the high impedance buffer stage. The second input of each of these muxes is the calibration signal. U6 is a buffer which drives the muxes with either zero volts or +0.324 volts reference levels (the way this is used for calibration will be described later).

U9 is an octal 8 bit DAC which serves several purposes. Four of its outputs are used to adjust the top and bottom references of the acquisition ADCs (REFBADJ1, REFTADJ1, REFBADJ2 and REFTADJ2). It also provides control of the trigger threshold and the trigger hysteresis (VTH and TR HYST).

U2 is the reference standard and generates 8.192 volts precisely. Resistive dividers, and the buffers U10A&B, provide reference inputs to the octal DAC, U9.

The calibration procedure for the vertical system is as follows:

1) Initial Set-Up

Each channel is calibrated in the same way. The input grounding relay is set to the 'ground' position, and both input attenuators are selected in order to minimize crosstalk due to any input signals. The muxes U8 and U9 are addressed to provide ground reference on the offset lines. Each channel is set to 100mV/division. The REFT and REFB inputs to ADC1 and ADC2 are set to a nominal level.

2) Calibrating The Offset DACs

With Channel 1 selected as the source for ADC1, the ADC code corresponding to 'ground' is measured (this is done with many traces averaged in order to achieve sufficient accuracy). Next, the reference level for CH1 OFFSET is set to +0.324 volts, and the code corresponding to this level is measured on ADC1. U8 mux then selects Channel 1 offset DAC as the source for CH1 OFFSET; the code input to U4A offset DAC is adjusted until two codes produce the same ADC codes as +0.324 volts and ground. This process calibrates the offset DAC.

3) Calibrating The Vertical Ranges

Now, the offset DAC can produce known DC offset levels to calibrate each of the vertical volts/division settings. This procedure consists of inputting known levels and adjusting the REFT and REFB levels on ADC1 until the correct gain and offset codes are produced. The REFT and REFB levels for each vertical range are stored in a look-up table and recalled when the appropriate range is selected after calibration.

The above procedure is repeated for each of the four channels.

4.1.3 Acquisition System

The LS140 oscilloscope has two 200MS/sec 8-bit A/D converters which run at a fixed conversion rate independent of Time/Div setting. The signal source selection for these converters is determined by the Vertical Multiplexers. One A/D converter can digitize Channel 1 or 3, and the other converter can digitize Channel 2 or 4. This selection is determined by control bits programmed by the ISA Bus Interface Card (assembly reference 724-F-5) through the Shift Register chain.

The acquisition cycle shares the two A/D converters between four channels in an 'alternate' mode similar to a Non-Storage oscilloscope with single beam CRT. Figure 4.1.3 shows how channels 1 and 2 are digitized with the record fixed relative to the trigger point. This is followed by channels 3 and 4 being digitized with the same fixed time relation to the trigger point. After all four channels have been digitized in this way, the displayed traces are updated.

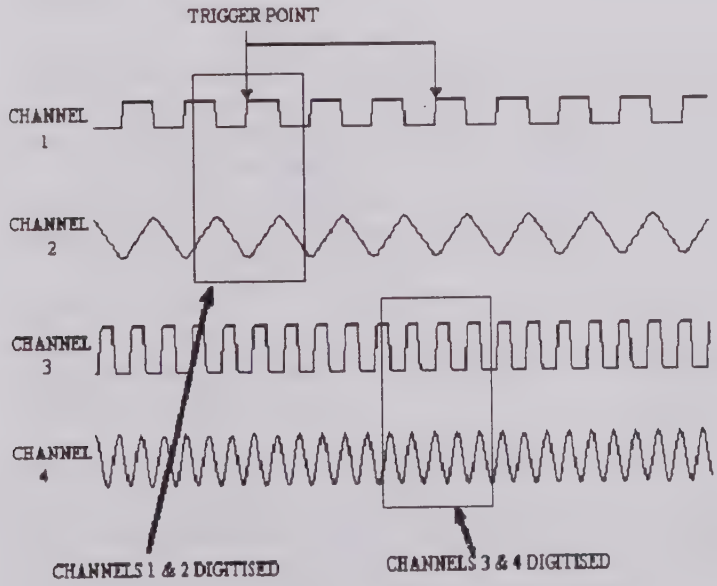


Figure 4.1.3: Alternate mode display of 4 channels with 2 A/D converters.

4.1.3 Acquisition System (continued)

The outputs of the A/D converters are passed to the MIN/MAX & DEMUX circuits which convert the 8-bit 200MS/sec data streams to 16-bit data streams at 100MS/sec or slower. The data consists of 8-bit deflection values to be stored in Acquisition memory. If ALIAS PROTECT mode is selected the data stream consists of MIN and MAX pairs of deflection values. Latches convert the 16-bit data stream (ECL 10KH levels) to a 32-bit (TTL compatible) data stream which is stored in Acquisition Random Access Memory (RAM). The Timebase Address Generator consists of counters that provide an address bus to the Acquisition RAM. Deflection data values are written into consecutive Acquisition RAM locations until enough data is acquired to fill the display from the trigger point to the end of record.

Selection of ALIAS PROTECT mode is determined by control bits programmed by the ISA Bus Interface Card (assembly reference 724-F-5) through the Shift Register chain.

The Timebase Generator ends the acquisition cycle. The Acquisition RAM switches from write mode to read mode, ready for the Processor Board to start acquisition read operations.

4.1.4 Clock Source And Distribution

This block supplies the 200MHz clock for use by the acquisition, timebase and trigger systems. It also provides a synchronous 50MHz clock for use by the timebase system.

4.1.5 Timebase System

This basically consists of a LeCroy proprietary timebase integrated circuit, the MTB411, together with a 40MHz oscillator and clock routing logic. The MTB411 controls the acquisition cycle and selects the appropriate timebase clocks required for the Time/Div and memory length selections. It provides addressing for the acquisition RAM and control signals for the acquisition cycle. A number of its counters are used by the Digital Trigger block.

4.1.6 Trigger System

The trigger system comprises of the Trigger Select/Conditioning block and the Digital Trigger/TDC block.

4.1.6.1 Trigger Select/Conditioning Block

The TMUX circuit (See TMUX.SCH) simply multiplexes the signal from any one of the four input channels or from the LINE trigger into the trigger comparator. It also multiplexes the input signals to the TV trigger system.

4.1.6.1 Trigger Select/Conditioning Block (continued)

The trigger transmission lines from each channel are terminated via R40, R41, R42 and R43. U40 is a quad DMOS switch; inconjunction with Q40, a single DMOS switch, it selects one of the four channels or the line trigger as the trigger source. Selected trigger signals appear at pin 8 of U41, the trigger conditioner and comparator.

U41 allows selection of all the normal trigger coupling modes via the mode select lines (S(DC) etc.). The VTH input defines the trigger comparator threshold, and the TR HYST line allows calibration of trigger hysteresis.

See Table 4.0 for details of the mode selection logic. L47 and C47 define the trigger bandwidth limit -3dB frequency; C46 defines the AC coupling -3dB frequency, and C50 defines the HF Reject -3dB frequency. Complementary ECL - compatible outputs are NOUT and POUT.

COUPLING	S(DC)	S(BWL)	S(HFR)	S(ACR)
DC	H	L	L	L
DC & BWL	L	H	L	L
AC	H	L	L	H
AC & BWL	L	H	L	H
LFR	H	L	H	L
LFR & BWL	L	H	H	L
HFR	L	L	H	L

Table 4.0 Trigger Coupling Mode Selection Logic

4.1.6.2 Digital Trigger/TDC Block

Control of the digital part of the trigger system (Smart Trigger) is implemented from within the Control block (See FIG 4.2). This consists of a set of latches and TTL-ECL level shifters for interfacing to the ECL logic within the Digital Trigger. The data held in the latches is controlled by the firmware.

The Digital Trigger comprises of the following blocks:

1) Digital Trigger Mux,
2) TV Trigger,
3) Trigger Synchronizer,
4) Width/Holdoff Clock,
5) Qualify & Reset, and
6) TDC

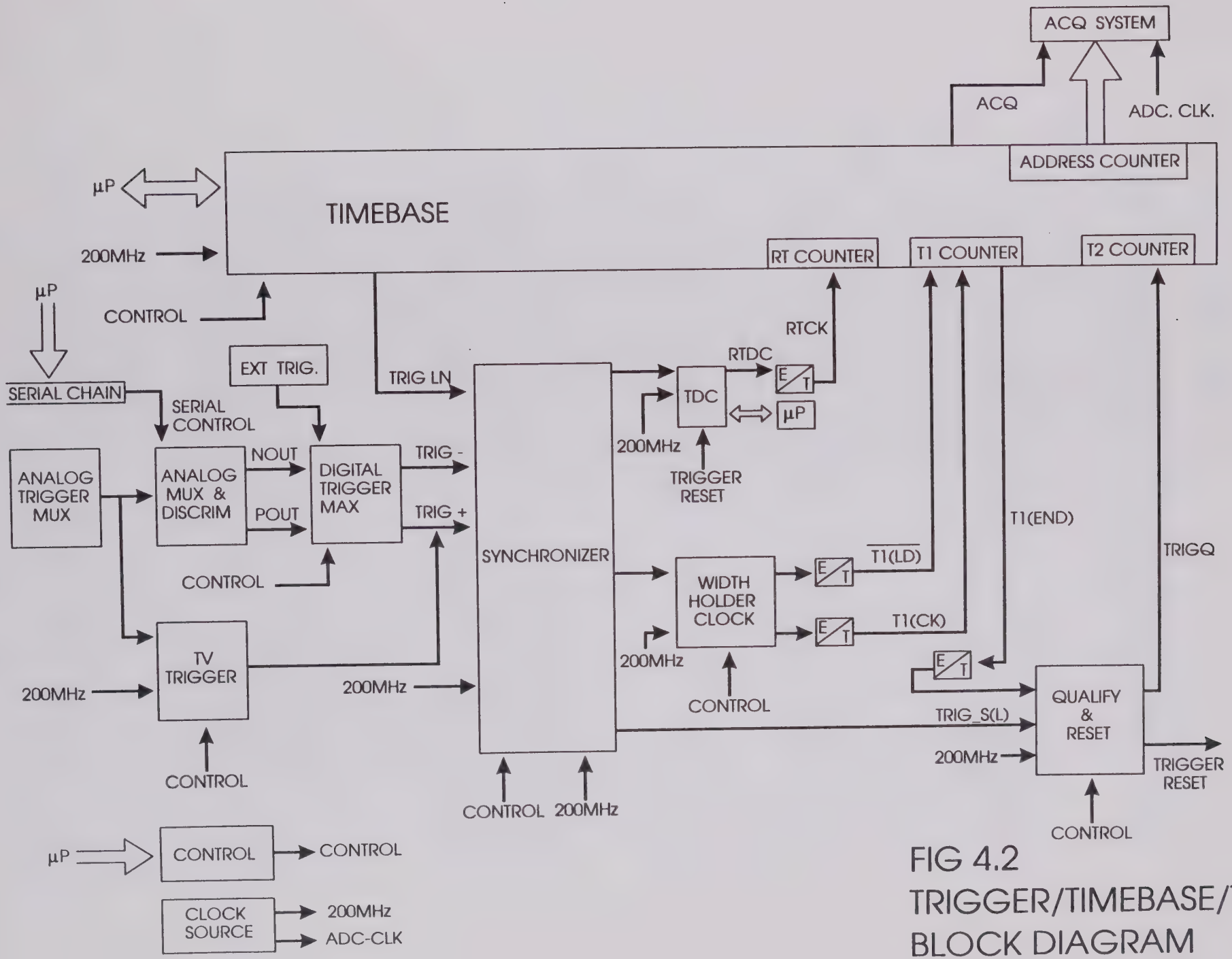


FIG 4.2
TRIGGER/TIMEBASE/TDC
BLOCK DIAGRAM

4.1.6.2.1 Digital Trigger MUX

The Digital Trigger Mux selects either the outputs from the discriminator in the Analog Trigger system (POUT, NOUT), or from an external source via connector J901. The mux output is passed to the Trigger Synchronizer.

4.1.6.2.2 TV Trigger

The TV Trigger block is supplied from the output of the Analog Trigger Mux. It consists of a video amplifier with automatic gain control, feeding a video sync separator in order to obtain a composite sync output. This composite sync output is muxed to the Trigger Synchronizer and Width/Holdoff Clock blocks. The Width/Holdoff Clock synchronizes the composite sync and uses this to clock the T1 counter in the MTB411.

4.1.6.2.3 Trigger Synchronizer

The function of the Trigger Synchronizer is to latch the trigger event and provide signals to the TDC in order to obtain phase information between the event and system clock. The Trigger Synchronizer also produces control signals for the T1 counter.

4.1.6.2.4 Width/Holdoff Clock

The Width/Holdoff Clock supplies clocks to be used by the T1 counter. The source can either be an internally generated 50MHz signal, or the selected trigger source signal synchronized against the 50MHz clock.

4.1.6.2.5 Qualify & Reset

The Qualify & Reset block compares the occurrence of a 200MHz synchronized trigger event against the time-out of the T1 counter. Depending on the Smart Trigger mode selected, it will then generate either a qualified trigger signal (TRIGQ), or a trigger system reset (TRIGRESET). Occurrence of a qualified trigger event (i.e. an event that meets the trigger criteria) initiates the trigger delay period. The T2 counter in the MTB411 is used to count timebase clocks in order to obtain the required delay. When this delay period expires, a signal (TRIGD) is generated to complete the acquisition cycle.

4.1.6.2.6 TDC

The TDC is used to obtain phase information between the trigger event and the system clock. This information is used to correctly position sampled data in RIS timebase ranges. It consists of an integrator, sample & hold and ADC to obtain phase information between the event and the 200MHz system clock, and a counter to obtain the relationship between the 200MHz clock and the 50MHz timebase clock (TBCK). The RT counter in the MTB411 is used for this latter function.

4.2 ISA BUS INTERFACE CARD (ASSEMBLY 724-F-5)

4.2.1 General

This circuit plugs into the ISA bus backplane on the Processor Board (assembly 724-F-48) from which it gets all it's power, control and timing signals.

Two forty-way IDC ribbon cables connect to the Acquisition board (assembly 724-F-1). One carries control to the Trigger and Timebase System and reads data from the Trigger system and probe coding circuits. The other carries Acquisition read addresses to the Acquisition Random Access Memories (RAM) and reads deflection data values from the Acquisition RAMs. The data path the Processor Board from the Acquisition and Trigger systems have buffers to reduce Processor bus loading.

A twenty-way cable connects the Front Panel processor to the Front Panel Controls (assembly 724-F-2). This cable carries one signal that connects to the Video Interconnect Card (assembly 724-F-3) to blank the CRT during power-up.

A connector provides power for a fan mounted on the rear panel.

A connector is provided for an additional cell or battery to be fitted when the existing memory backup cell fails.

Memory, control registers and data registers on the ISA Bus Interface card have Addresses allocated from the Processor Board's Memory and IO address space. Bank switching selects one of a number of memory 'pages' for Operating System and Acquisition System memory accesses. Indexed IO addressing selects one of a number of registers for control or data transfer.

4.2.2 Interface Card Memory

The Interface Card provides the LS140 with several memory devices for temporary and permanent storage of executable code, configuration tables and waveform storage. The Oscilloscope Software that controls the basic operation of the LS140 is held in battery-backed RAM. The LS140 Oscilloscope Software can be upgraded from a floppy disk. New software can be loaded (and verified) if a LeCroy Software Distribution Disk is inserted and the power cycled.

The LS140 Operating System firmware is stored in a non-volatile EPROM on this board. The Processor Board finds this code and executes it at power-up. If the Processor is unable to execute this code, the Oscilloscope will not function at all. This Operating System provides the interface between the Oscilloscope Software and the Processor Board.

4.2.2 Interface Card Memory (continued)

384kbytes* of Random Access Memory (RAM) is provided for storage of the Oscilloscope Software. After the Processor Board has executed the Operating System Program it loads the Oscilloscope Software into the Processor Board System Memory for Execution. The LS140 is now ready to self-calibrate and operate as an oscilloscope. This area of RAM has a Lithium Cell to provide a power supply when the LS140 is switched off. The Program stored in this RAM will not be lost during power cycles.

128kbytes of RAM is provided for storage of waveforms. This area of RAM has a Lithium Cell to provide a power supply when the LS140 is switched off. Stored waveforms are not lost during power cycles.

*The option configurations available may require more RAM for their operation. If an attempt is made to load Oscilloscope Software for an option configuration without the additional RAM installed, the verification cycle will fail and the operator will be instructed to return the LS140 to a LeCroy service center.

4.2.3 Acquisition Memory Interface

Acquisition RAM is mapped to part of the Processor Board's Memory address space. Selection of individual RAM devices for read operations is determined by the Index Register on the ISA Bus Interface Card.

4.2.4 Acquisition Control Interface

The control of the Acquisition Board relays (in attenuator circuits), amplifiers, Input Coupling and Bandwidth, Vertical deflection and Trigger source multiplexers, Trigger coupling, Acquisition Mode, Trigger Level and Sensitivity, Vertical Deflection Offset and Vertical Deflection gain calibration adjustments are all programmed by generating a serial data stream of control bits with a clock signal. The ISA Bus Interface Card generates this stream under control of the Processor Board.

The signal required to load the control bits into the output registers of the drivers is generated on the Acquisition Board (assembly 724-F-1) under control of the Processor Board.

4.2.5 Trigger Control Interface

Five 8-bit Trigger system control registers and the control registers of the Timebase Circuit are mapped into the Processor Board's IO address space. Selection of individual registers for read or write operations is determined by the Index Register on the ISA Bus Interface Card.

A counter on the ISA Bus Interface Card generates a 0.44725MHz clock for the A/D converter on the Acquisition Board that measures the Probe Coding Ring voltages and the TDC output. The clock source for this counter is the 14.31818MHz reference on the ISA bus.

4.2.6 Front Panel Processor

The Front Panel Switch matrix and Rotary Switch are constantly scanned by the Front Panel Processor on the ISA Bus Interface Card. The Front Panel Processor is mapped to an indexed location in the Processor Board's IO address space.

4.2.7 Speaker

A speaker is mounted on the ISA Bus Interface Card with a connector for a cable to the Processor Board. The Processor Board generates an audible signal during power-up self test and whenever a front panel key is pressed.

DISASSEMBLY

5.0 INTRODUCTION

This section includes the instrument disassembly and replacement procedures.

WARNING	DISASSEMBLY DESCRIBED IN THIS SECTION IS PERFORMED WITH POWER REMOVED FROM THE INSTRUMENT. DO NOT REMOVE OR REPLACE ANY OF THE CIRCUIT BOARD ASSEMBLIES WITHOUT FIRST VERIFYING THAT POWER HAS BEEN REMOVED FROM THE INSTRUMENT. ANTI-STATIC PROTECTION MEASURES SHOULD BE TAKEN PRIOR TO THE HANDLING OF ANY PRINTED CIRCUIT BOARDS.

5.1 CABINET REMOVAL

1. Disconnect power cable from the instrument.
2. Place the LS140 face down into the plastic front panel protective cover that was shipped with the unit or on a soft surface to protect the BNC's and front panel knob.
3. Remove the four screws attaching the rear feet to the rear bezel as shown in Fig. 5.1
4. Remove the six screws attaching the cabinet to the rear bezel as shown in Fig. 5.1
5. Hold the cabinet by the two sides. Carefully lift the cabinet using a left and right rocking motion.
6. Figure 5.2 shows all of the individual parts of the cabinet assembly.

5.2 CABINET REPLACEMENT

1. Verify that all cables are neatly tucked out of the way. Make sure the end of the ribbon cables connecting the 724-F-1 and 724-F-5 (J3 & J4) are folded down toward the 724-F-5 board. See Fig. 5.3.
2. Hold the cabinet by the two sides. Make sure you have the cabinet at the correct orientation (i.e., the kick stand is facing the bottom of the unit). Carefully slide the cabinet down using a left and right rocking motion.
3. Replace the four feet and screws attaching the rear feet to the rear bezel as shown in Fig. 5.1.
4. Replace the six screws attaching the cabinet to the rear bezel as shown in Fig. 5.1.

5.3 MAIN POWER SUPPLY REMOVAL (724-F-47)

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Unplug all of the power supply feeds (P1-P6, J7013) from the 724-F-7 power supply interconnect board and disk drive(s) as shown in Fig. 5.3 & Fig. 5.6.
3. Remove the screw attaching the green ground wire from the power supply to the bottom of the main chassis near the power interconnect board as shown in Fig. 5.3.
4. Remove the two screws attaching the power supply to the side of the chassis as shown in Fig. 5.4.
5. Remove the four screws attaching the power supply to the rear panel as shown in Fig. 5.5.
6. Lift the power supply straight up through the top of the chassis.

5.4 MAIN POWER SUPPLY REPLACEMENT (724-F-47)

1. Reverse the removal procedure to install the power supply.

5.5 ACQUISITION BOARD REMOVAL (724-F-1)

NOTE HIGHLY STATIC SENSITIVE ASSEMBLY!

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Disconnect the power harness and line transformer from the acquisition board (J499 & J10) as shown in Fig. 5.6.
3. Disconnect the black wire, attached to the probe adjust on the front bezel, from the main board (J80) as shown in Fig. 5.7.
4. Remove the two screws attaching the front panel BNC's shield to the front bezel as shown in Fig. 5.4.
5. Remove the (11) screws attaching the acquisition board (724-F-1) to the chassis as shown in Fig. 5.4.
6. Carefully lift the acquisition board up and toward the rear of the unit sliding the BNC's from the front bezel.

5.6 ACQUISITION BOARD REPLACEMENT (724-F-1)

1. Reverse the removal procedure to install the acquisition board.

5.7 LS140 I/O BOARD REMOVAL (724-F-5)

NOTE	HIGHLY STATIC SENSITIVE ASSEMBLY!

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Unplug the two fan wires from the I/O card at connector J5006 as shown in Fig. 5.3.
3. Unplug the two ribbon cables connecting the I/O card to the acquisition board (724-F-1) at connectors J4 & J5 as shown on Fig. 5.3.
4. Remove the two screws attaching the 724-F-5 holding brackets to the side rail as shown in Fig. 5.7.
5. Remove the screw that attaches the rear mounting bracket of the I/O card to the rear bezel as shown in Fig. 5.7.
6. Using a rocking motion toward the front and rear of the unit, lift the I/O card out of the edge connector of the main CPU board as shown in Fig. 5.7.

5.8 LS140 I/O BOARD REPLACEMENT (724-F-5)

1. Reverse the removal procedure to install the I/O board.

5.9 REAR COOLING FAN REMOVAL

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Unplug the rear fan power wires from the 724-F-5 (J5003) as shown in Fig. 5.3.
3. Remove the two screws attaching the fan to the rear panel as shown in Fig. 5.5.

5.10 REAR COOLING FAN REPLACEMENT

1. Reverse the removal procedure to install the cooling fan.

5.11 AUXILIARY POWER SUPPLY REMOVAL (50 WATT)

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Unplug the cables connecting the 724-F-7 (Power interconnect board) to the power supply (J2 & P1) as shown in Fig. 5.6.
3. Remove the four screws attaching the power supply to the chassis as shown in Fig. 5.8.

5.12 AUXILIARY POWER SUPPLY REPLACEMENT (50 WATT)

1. Reverse the removal procedure, up to replacing the cabinet, to install the auxiliary power supply.
2. Adjust the power supply (Sect. 3.2).
3. Perform the cabinet replacement procedure (Sect. 5.3).

5.13 MONITOR KIT REMOVAL

WARNING	OBSERVE CAUTION, HIGH VOLTAGE MAY BE PRESENT ON THE CRT AND VIDEO ASSEMBLY EVEN WITHOUT POWER APPLIED!

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Cut the tie-wrap holding the red high voltage wire, from the CRT driver board, to the metal eye hook connected to the neck of the CRT as shown in Fig. 5.7.
3. Remove the High Voltage Anode cable from the CRT as shown in Fig. 5.7. Use an INSULATED pair of long nose pliers. Pull back the rubber boot by its edges enough to expose the metal clip at the end of the cable. Grab the metal clip with the insulated pliers and pinch the clip. Once the clip is removed from the CRT touch it to a metal side member of the unit to discharge any voltage that may be stored.
4. Remove the adjustment diagram from the top of the CRT driver board shield.
5. Remove the plastic clip holding the CRT driver board shield to the center member of the main chassis as shown in Fig. 5.6.
6. Disconnect the ribbon cable from the rear of the floppy drive and move it out of your way.
7. Remove the three screws attaching the CRT driver board shield to the main chassis assembly as shown in Fig. 5.8.
8. Remove the shield from the unit by slipping the black boot, connected to the red high voltage cable, through the hole in the shield.
9. Remove the two screws attaching the CRT driver board to the center member of the main chassis as shown in Fig. 5.8.
10. Remove the CRT driver board by lifting it up and out of the edge card connector it is sitting in.
11. Place the LS140 face down into the plastic front panel protective cover that was shipped with the unit or on a soft surface to protect the BNC's and front panel knob.
12. Remove the four screws attaching the CRT to the front panel as shown in Fig. 5.4.
13. Carefully lift and remove the CRT from the unit.

5.14 MONITOR KIT REPLACEMENT

1. Reverse the removal procedure, up to replacing the cabinet assembly, to install the monitor kit.
2. Adjust the CRT (Sect. 3.1).
3. Perform the cabinet replacement procedure (Sect. 5.2).

5.15 FLOPPY DRIVE REMOVAL

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Disconnect the ribbon cable and power cable from the rear of the floppy drive.
3. Perform the Monitor Kit Removal procedure steps 2-8.
4. Remove the two screws attaching the floppy drive to the main chassis assembly as shown in Fig. 5.4.
5. Hold the floppy drive and remove the two screws attaching the floppy drive to the side rail as shown in Fig. 5.4.
6. Slide the floppy drive out from the rear of the front bezel.

5.16 FLOPPY DRIVE REPLACEMENT

1. Reverse the removal procedure to install the floppy drive. Before tightening the screws on the floppy drive make sure the drive is perpendicular to the front bezel and not tilted.

5.17 FRONT PANEL REMOVAL

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Disconnect the ribbon cable connecting the front panel board to the 724-F-7 video interconnect board as shown in Fig. 5.6.
3. Disconnect the four wires attached to the rear of the front panel power switch as shown in Fig. 5.6.
4. Place the LS140 face down into the plastic front panel protective cover that was shipped with the unit or on a soft surface to protect the BNC's and front panel knob.
5. Remove the two screws attaching the two top side rails to the front bezel as shown in Fig. 5.4.
6. Remove the screw attaching the front bezel to the bottom side rail just below the front panel power switch as shown in Fig. 5.4.
7. Remove the two bottom screws attaching the CRT to the front bezel as shown in Fig. 5.4.

5.17 FRONT PANEL REMOVAL (continued)

8. While applying pressure on the front panel holding the unit together, gently lie the unit down so that the unit is sitting right side up.
9. Remove the two top screws attaching the CRT to the front bezel as shown in Fig. 5.4.
10. Hold on to the CRT and gently remove the front bezel from the rest of the chassis.

5.18 FRONT PANEL REPLACEMENT

1. Reverse the removal procedure to install the front panel.

5.19 FRONT PANEL PC BOARD REMOVAL

1. Perform the Front Panel Removal Procedure (Sect. 5.17).
2. Remove the front panel control knob by simply pulling it off as shown in Fig. 5.9.
3. Remove the four screws attaching the front panel to the front bezel as shown in Fig. 5.9.
4. Lift front panel from front bezel.

5.20 FRONT PANEL PC BOARD REPLACEMENT

1. Reverse the removal procedure steps 2-4 to install the front panel PC board.
2. Perform the Front Panel Replacement Procedure (Sect. 5.18).

5.21 FRONT PANEL KEYPAD REMOVAL

1. Perform the Front Panel PC Removal Procedure (Sect. 5.19).
2. Lean front bezel back and allow keypad to fall out from the bezel.

5.22 FRONT PANEL KEYPAD REPLACEMENT

1. Place the keypad face down into the rear of the bezel.
2. Hold the front bezel up and visually inspect all of the keys are through their respective holes in the front bezel.
3. Place the front panel PC board onto the keypad. Check that the alignment pins are visible.
4. Perform the front panel PC replacement procedure (Sect. 5.20).

5.23 FRONT PANEL ROTARY CONTROL REMOVAL

1. Perform the front panel PC removal procedure (Sect. 5.19).
2. Remove the nut and washer attaching the control knob to the front panel.
3. Unsolder the control knob from the gold pad side of the front panel.

5.24 FRONT PANEL ROTARY CONTROL REPLACEMENT

1. Reverse the front panel rotary control removal to install the front panel rotary control.

5.25 GENERIC I/O CARD REMOVAL

> NOTE HIGHLY STATIC SENSITIVE ASSEMBLY!

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Locate the card to be replaced by using Fig. 5.3 as a reference.
3. Remove the screw that attaches the rear mounting bracket of the I/O card to the rear bezel as shown in Fig. 5.7.
4. Using a rocking motion toward the front and rear of the unit, lift the I/O card out of the edge connector of the main CPU board as shown in Fig. 5.7.

5.26 GENERIC I/O CARD REPLACEMENT

> NOTE HIGHLY STATIC SENSITIVE ASSEMBLY!

1. Reverse the generic I/O card removal procedure to install a generic I/O card.

5.27 MAIN CPU REMOVAL (724-F-48)

> NOTE HIGHLY STATIC SENSITIVE ASSEMBLY!

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Perform the LS140 and generic I/O card removal procedures (Sect. 5.7 & 5.25).
3. Remove the seven nuts and washers holding the main CPU board to the bottom mounting plates as shown in Fig. 5.8.

5.28 MAIN CPU REPLACEMENT (724-F-48)

NOTE	HIGHLY STATIC SENSITIVE ASSEMBLY!

1. If the replacement board is not exactly the same board as the original, the CPU mounting plates may have to be replaced. If needed, remove the six screws attaching the mounting plates to the bottom of the main chassis as shown in Fig. 5.26. Install the mounting plates included with the replacement CPU board (724-F-48 kit). Secure the mounting plates by inserting six mounting screws and seven nylon spacers as shown in Fig. 5.10.
2. Reverse the main CPU removal procedure.

5.29 POWER INTERCONNECT BOARD REMOVAL (724-F-7)

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Unplug the main CPU card power harness at J1 & J2 as shown in Fig. 5.3.
3. Unplug the AC power connectors at J7012 & J7013 near the front of the power interconnect board as shown in Fig. 5.3 & Fig. 5.6.
4. Unplug the main power supply harness at P1, P2, and P4 on the power interconnect board as shown in Fig. 5.3 & Fig. 5.6.
5. Unplug the power connections to the auxiliary power supply at J2 and P1 as shown in Fig. 5.3 & Fig. 5.6.
6. Unplug the CRT driver board power cable at J7011 on the power interconnect board as shown in Fig. 5.3 & Fig. 5.6.
7. Unplug the acquisition board (724-F-1) main power harness (J10) as shown in Fig. 5.3 & Fig. 5.6.
8. Lift each corner of the power interconnect board while pinching the locking tabs of the plastic standoffs attached to the bottom of the main chassis and the power interconnect board.

5.30 POWER INTERCONNECT BOARD REPLACEMENT

1. Reverse the power interconnect board removal procedure to install the power interconnect board.
2. Make sure the board is fully locked down by the tabs on the plastic standoffs.

5.31 VIDEO INTERCONNECT BOARD REMOVAL (724-F-2)

1. Perform the cabinet removal procedure (Sect. 5.1).
2. Perform the monitor kit removal procedure steps 1-10 (Sect. 5.13).

5.31 VIDEO INTERCONNECT BOARD REMOVAL (724-F-2) (continued)

3. Remove the two ribbon cables from the interconnect board (@J3001 & J3003) as shown in Fig. 5.3.
4. Remove the two screws attaching the interconnect board to the main chassis assembly as shown in Fig. 5.10.
5. Hold the edge connector that the CRT driver board was inserted into and lift and tilt it toward the center member of the chassis.
6. Twist the board to clear the tabs on the center member of the chassis and pull the board out away from the center member.

5.32 VIDEO INTERCONNECT BOARD REPLACEMENT

1. Reverse the video interconnect board removal procedure to install the video interconnect board.

Code	Qty.	Part Number	Description	Usage
A	4	709-714-024 559-632-106 577-600-001 575-400-002	Foot Screw 6-32x3/8" Lockwasher #6 Flat Washer #4	Attaching Feet To Rear Of Cabinet.
B	6	559-632-106	Screw 6-32x3/8"	Attaching Cabinet To Main Assembly.

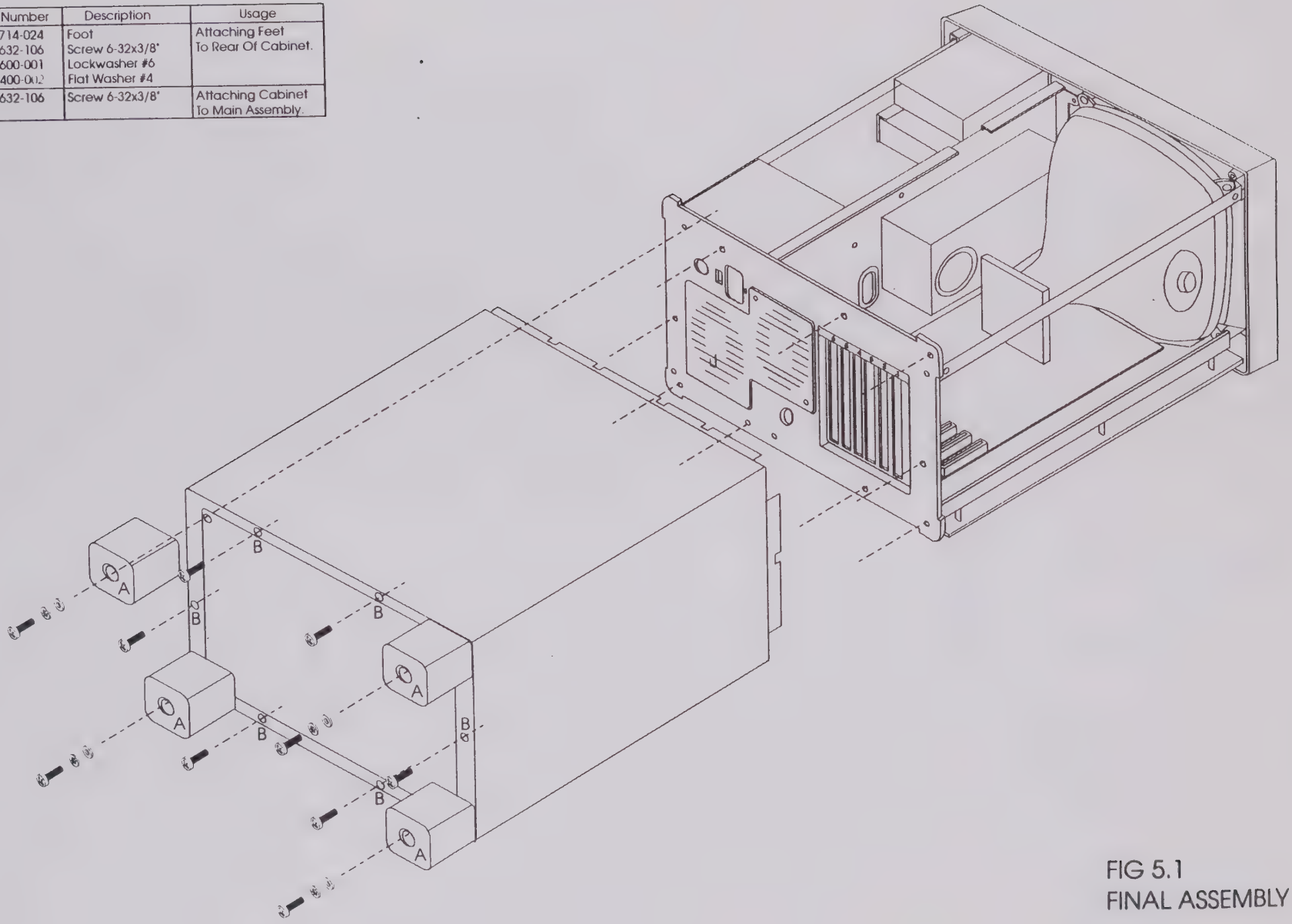


FIG 5.1
FINAL ASSEMBLY

Code	Qty.	Part Number	Description	Usage
A	4	559-632-008 577-600-001 581-632-002	Screw 6-32x1/2" Lockwasher #6 Nut #6	Assembly Of Feet To Cabinet.
B	4	559-632-004 577-600-001	Screw 6-32x1/2" Loclwasher #6	Assembly Of Handle Assembly.
C	2	559-632-106 577-600-001 581-632-002	Screw 6-32x1/2" Loclwasher #6 Nut #6	Attatching Of Bottom Feet To To Cabinet Assy.

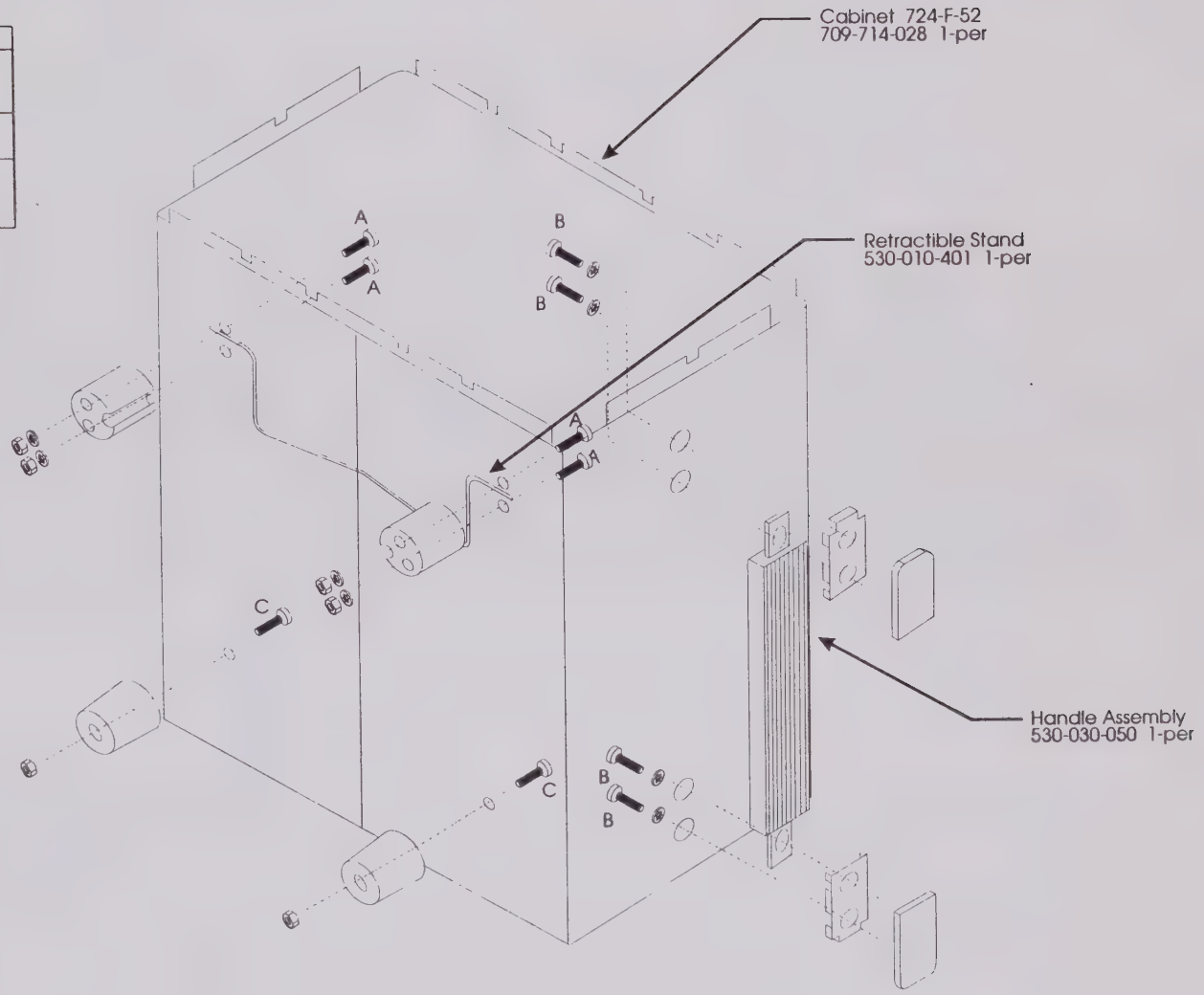
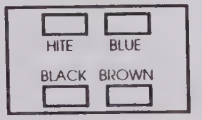


FIG. 5.2 CABINET ASSEMBLY

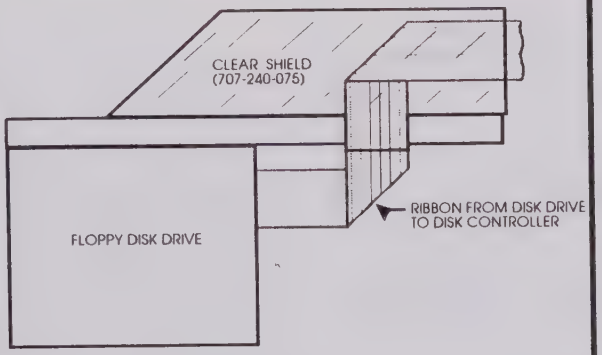
CABLE DETAIL 5.3

DETAIL A: POWER SWITCH

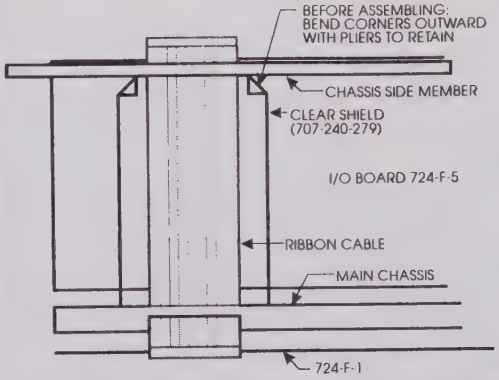


REAR VIEW OF SWITCH

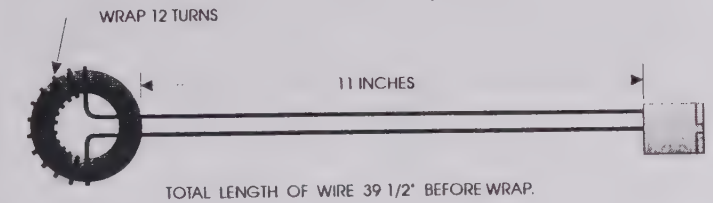
DETAIL B: FOLDING AND ADDING CLEAR SHIELD



DETAIL C: ASSEMBLY OF CLEAR SHIELD (2-PL.)



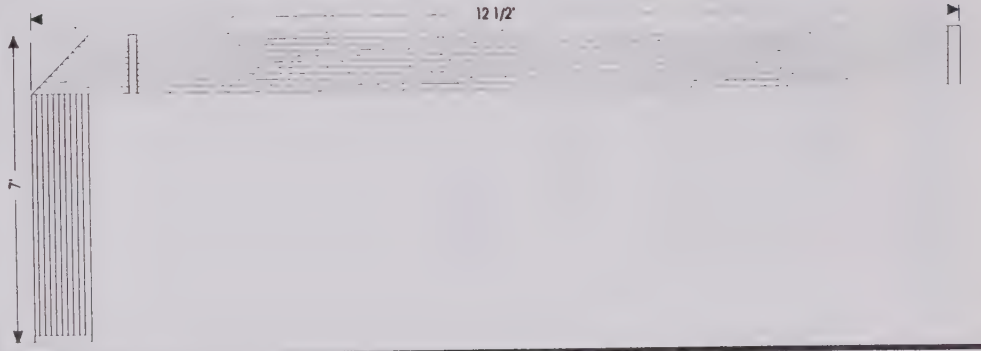
DETAIL D: ASSEMBLY OF 724-F-49



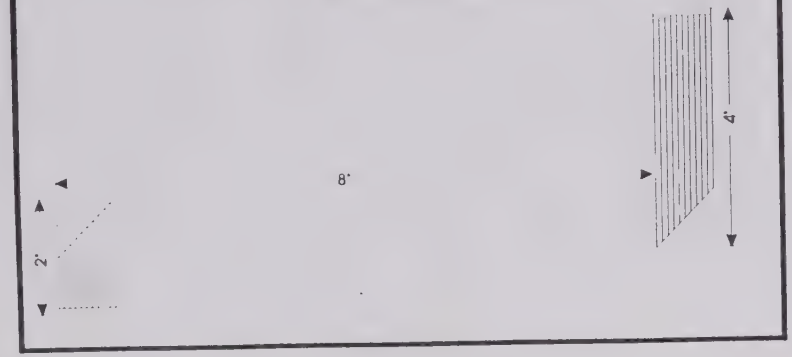
TOTAL LENGTH OF WIRE 39 1/2" BEFORE WRAP.

P/N	DESCRIPTION
300-060-004	2-PIN CONNECTOR
405-777-001	PINS 2-PER
455-123-003	MOLOX TRANSFORMER
590-001-018	BLK. 18 GAUGE

DETAIL E: FOLDING OF FRONT PANEL TO VIDEO INTER-CONNECT BOARD TO I/O CARD.



DETAIL F: FOLDING OF VGA CARD TO VIDEO INTERCONNECT BD



DETAIL G: FOLDING OF FLOPPY DISK DRIVE CABLE.

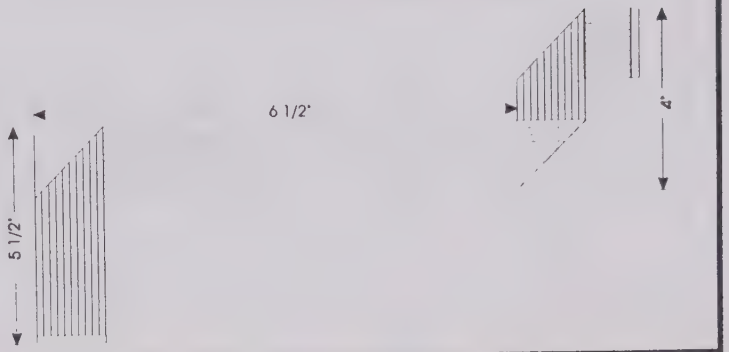


TABLE 5.3 CABLE INTERCONNECTION CHART

CABLE ASSEMBLY	FROM	TO
729-714-028 PRB. ADJUST	FRNT. PANEL	724-F-1 J80
487-240-071 INTERCONNECT BD (724-F-7) TO AC/DC POWER SUP	724-F-7 W7031-W7032	AUXILARY POWER SUPPLY P1 (315-160-110)
487-240-074 724-F-7 TO MONITOR BD.	724-F-7 J7011	ANALOG DISPLAY BOARD YELLOW + BLACK -
487-240-073 724-F-7 TO 724-F-1	724-F-7 W7013-W7024	24-F-1 J10
487-310-036 724-F-1 TO I/O BD (724-F-5)	724-F-1 J4	724-F-5 J5004 (I/O BD) (SEE DETAIL "C")
487-310-036 724-F-1 TO 724-F-5	724-F-1 J3	724-F-5 J5003 (SEE DETAIL "C")
487-310-037 FRONT PANEL TO VIDEO INTERCONNECT BD. TO I/O BD.	724-F-2 J5002	724-F-3 J3003 (VIDEO INTERCONNECT BD.) 724-F-5 J5002 (SEE DETAIL "E")
487-310-035 FDD CABLE	FLOPPY DISK DRIVE (330-003-202)	DISK CONTROLLER JP2 (334-010-001) SLOT #5 (SEE DETAIL "B" & "G")
487-310-039 VIDEO INTERCONNECT BD. (724-F-3) TO VGA CARD (724-F-4)	724-F-3 J3001	724-F-4 J1 (VGA CARD) SLOT #4 (SEE DETAIL "F")
487-240-072 724-F-7 TO POWER SUPPLY (724-F-47)	724-F-7 J7012	POWER SWITCH (411-128-080) (SEE DETAIL "A")
487-240-070 AC/DC POWER SUPPLY TO 724-F-7	AC\DC POWER SUPPLY J2	724-F-7 W7025-W7030
530-409-208 FAN	FAN (POWER)	724-F-5 J5006

TABLE 5.3 CABLE INTERCONNECTION CHART (continued)

CABLE ASSEMBLY	FROM	TO
724-F-47 (POWER SUPPLY)	P.S. BLACK WIRE (GREEN WIRE)	724-F-7 J7013 (GND TO ELECTRIC SHLD)
724-F-47	724-F-47 P1	724-F-7 J7010
724-F-47	724-F-47 P2	724-F-7 J7010
724-F-47	724-F-47 P4	724-F-7 J7003
724-F-47	724-F-47 P5	FLOPPY DRIVE J2
724-F-47	724-F-47 P3 & P6	DO NOT CONNECT
MONITOR KIT (321-210-099)	DISPLAY BD. CN001B	ANALOG DISPLAY BD. CN001A
MONITOR KIT	DISPLAY BD.CNOO2B	ANALOG DISPLAY BD. CNOO2A
MONITOR KIT	MONITOR 4-PIN CONN.	ANALOG DISPLAY BD. "DY" CONNECTOR
MONITOR MULTIPIER CABLE	MONITOR SIDE	ANALOG DISPLAY BD.
729-714-027 SPEAKER CABLE	724-F-48 J7 (MOTHER BOARD)	724-F-5 J5001
724-F-49	LOOP TRANSFORMER THROUGH WHITE WIRE OF POWER SWITCH	724-F-1
487-240-076 724-F-7 TO MOTHER BD. (724-F-48)	724-F-7 W7001-W7006	724-F-48 J2
487-240-077 724-F-7 TO 724-F-48	724-F-7 W7007-W7012	724-F-48 J1

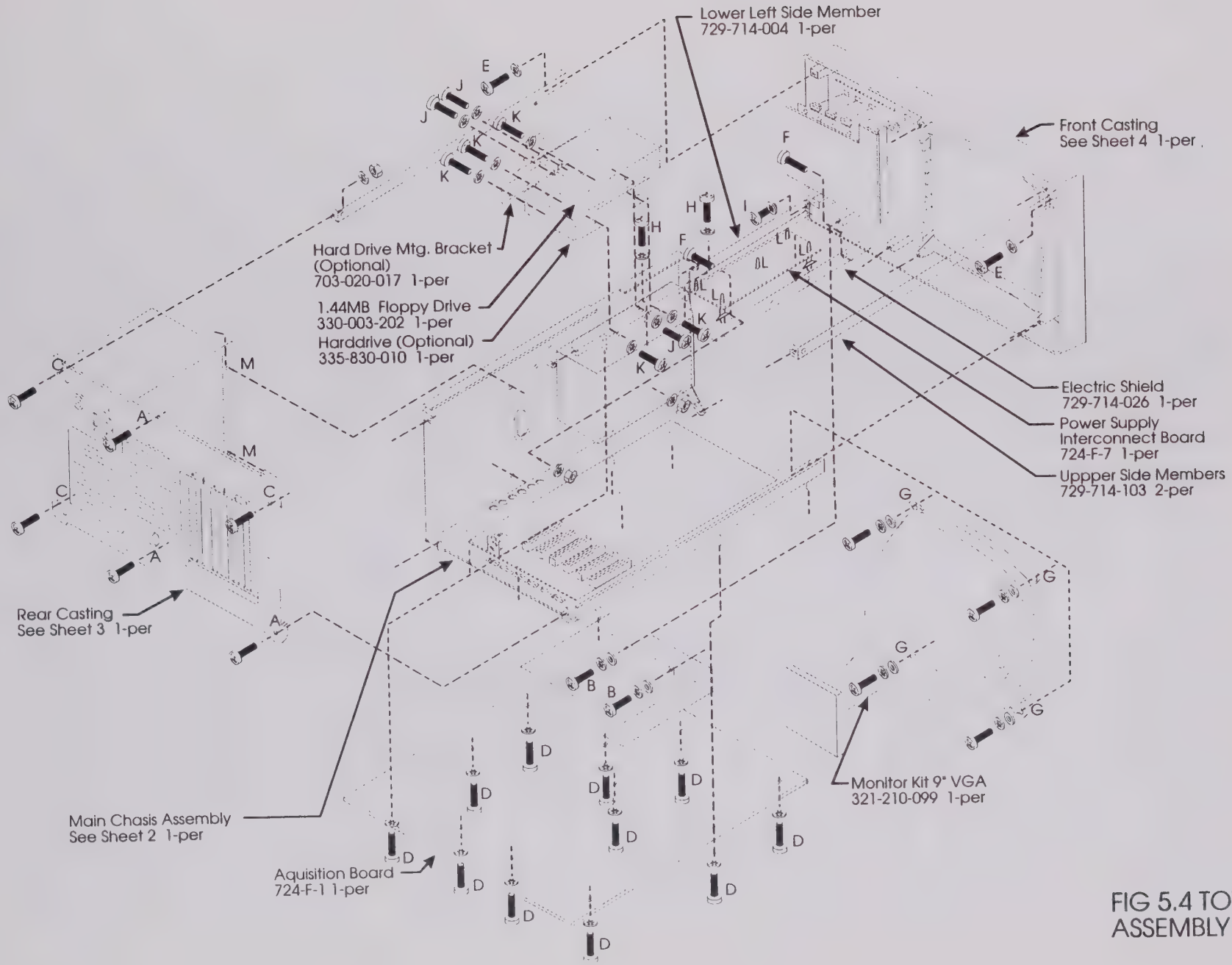


FIG 5.4 TOTAL
ASSEMBLY OVERVIEW

TABLE 5.4 TOTAL ASSEMBLY OVERVIEW HARDWARE

CODE	QTY.	PART NUMBER	DESCRIPTION	USAGE
A	3	568-632-007	Screw 6-32x7/16"	Assembly of rear casting to main chassis assembly.
B	2	560-632-006 577-600-001 575-400-002	Screw 6-32x3/8" Lockwasher #6 Flat Washer #4	Assembly of 724-f-1 to front casting.
C	3	568-632-007 577-600-001 581-632-000	Screw 6-32x7/16" Lockwasher #6 Nut #6	Assembly of rear casting to side members.
D	11	560-632-008 577-600-001	Screw 6-32x1/2" Lockwasher #6	Assembly of 724-f-1 to main chassis & lower side member.
E	2	560-632-006 577-600-001	Screw 6-32x3/8" Lockwasher #6	Assembly of side members to front casting.
F	2	560-632-006 577-600-001 581-632-002	Screw 6-32x3/8" Lockwasher #6 Nut #6	Assembly of electric shield to main chassis.
G	4	560-632-006 577-600-001 575-400-002	Screw 6-32x3/8" Lockwasher #6 Flat Washer #4	Assembly of monitor to front casting.
H	2	560-632-004 577-600-001	Screw 6-32x1/4" Lockwasher #6	Assembly of electric shield to side member.
I	1	560-632-006 577-600-001	Screw 6-32x3/8" Lockwasher #6	Assembly of left side member to front casting.
J	3	560-440-004 577-400-000	Screw 4-40x1/4" Lockwasher #6	Assembly of floppy drive to side member & chassis.
K	5	560-632-004 577-600-001	Screw 6-32x1/4" Lockwasher #6	Assembly of hard drive to bracket & main chassis.
L	5	530-041-009	Snap On Connectors	Assembly of power supply interconnect bd. To electric shield.
M	2	560-632-006 577-600-001 581-632-002	Screw 6-32x3/8" Lockwasher #6 Nut #6	Assembly of power supply to main chassis assembly.

Code	Qty.	Part Number	Description	Usage
A	4	567-632-007	Screw 6-32x7/16"	Assembly Of Power Supply To Rear Casting.
B	2	567-632-010 577-600-001 581-632-002	Screw 6-32x5/8" Locwasher #6 Nut #6	Assembly Of Fan To Rear Casting.

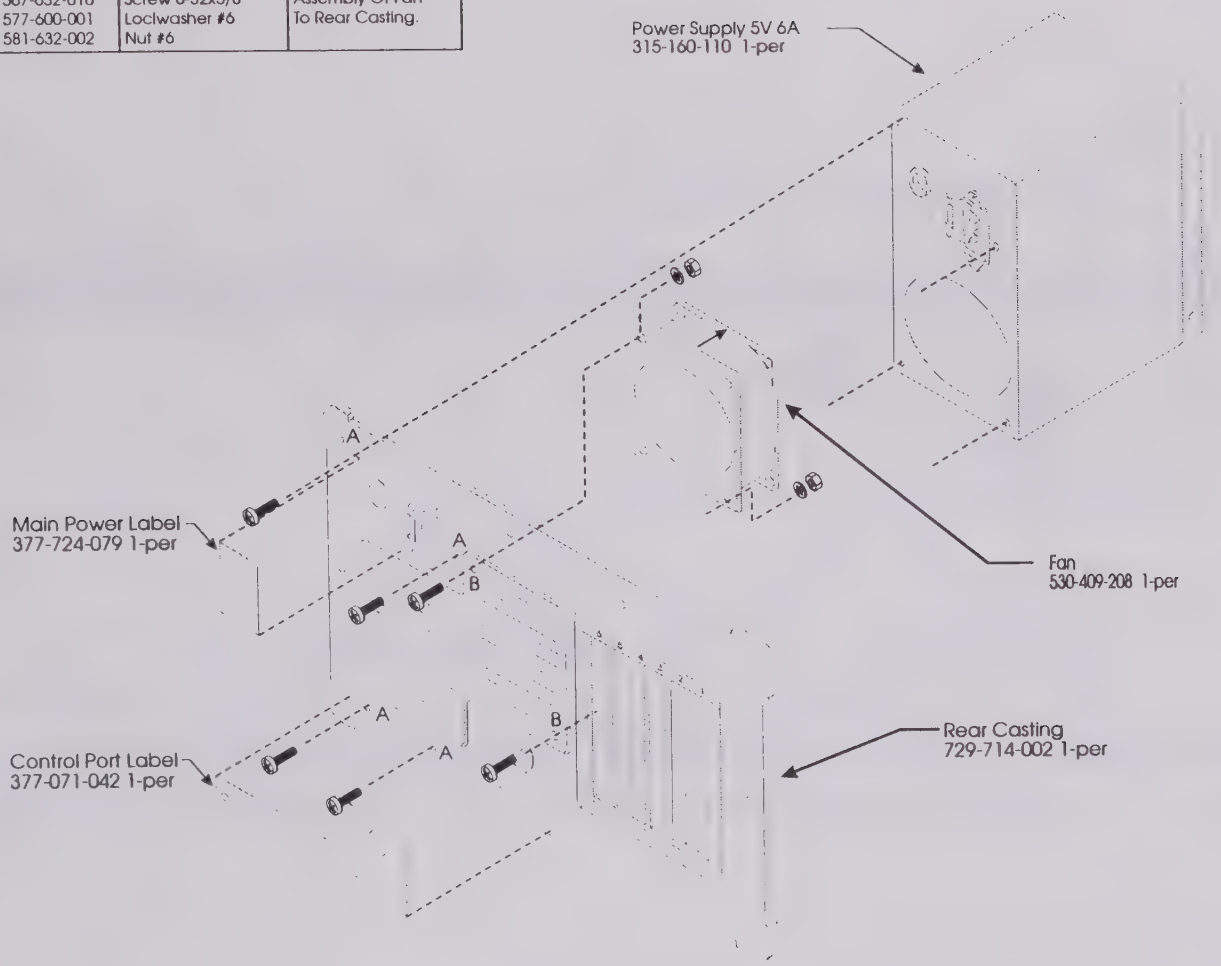


FIG 5.5 REAR CASTING ASSEMBLY

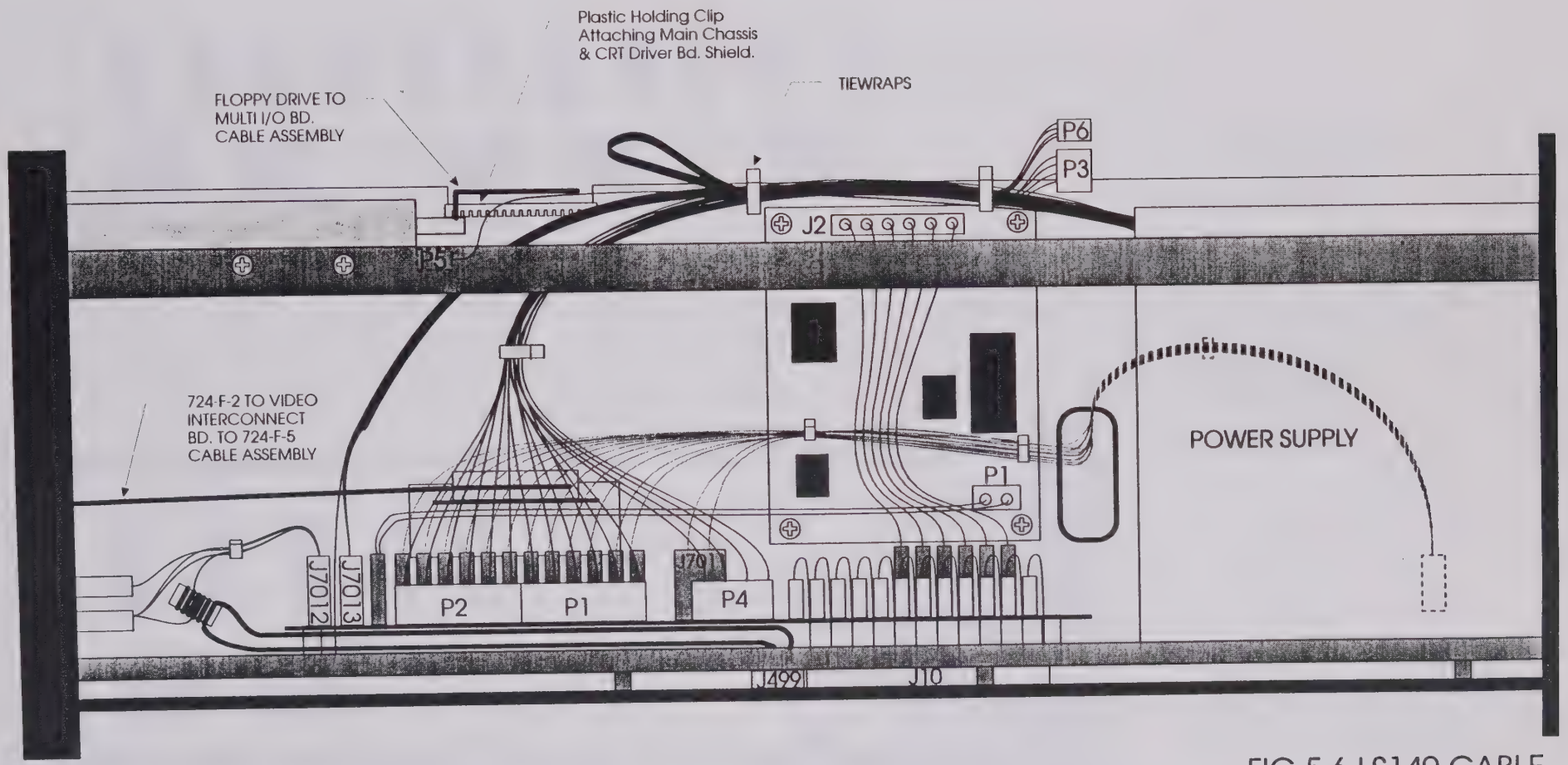


FIG 5.6 LS140 CABLE ASSEMBLY SIDE VIEW

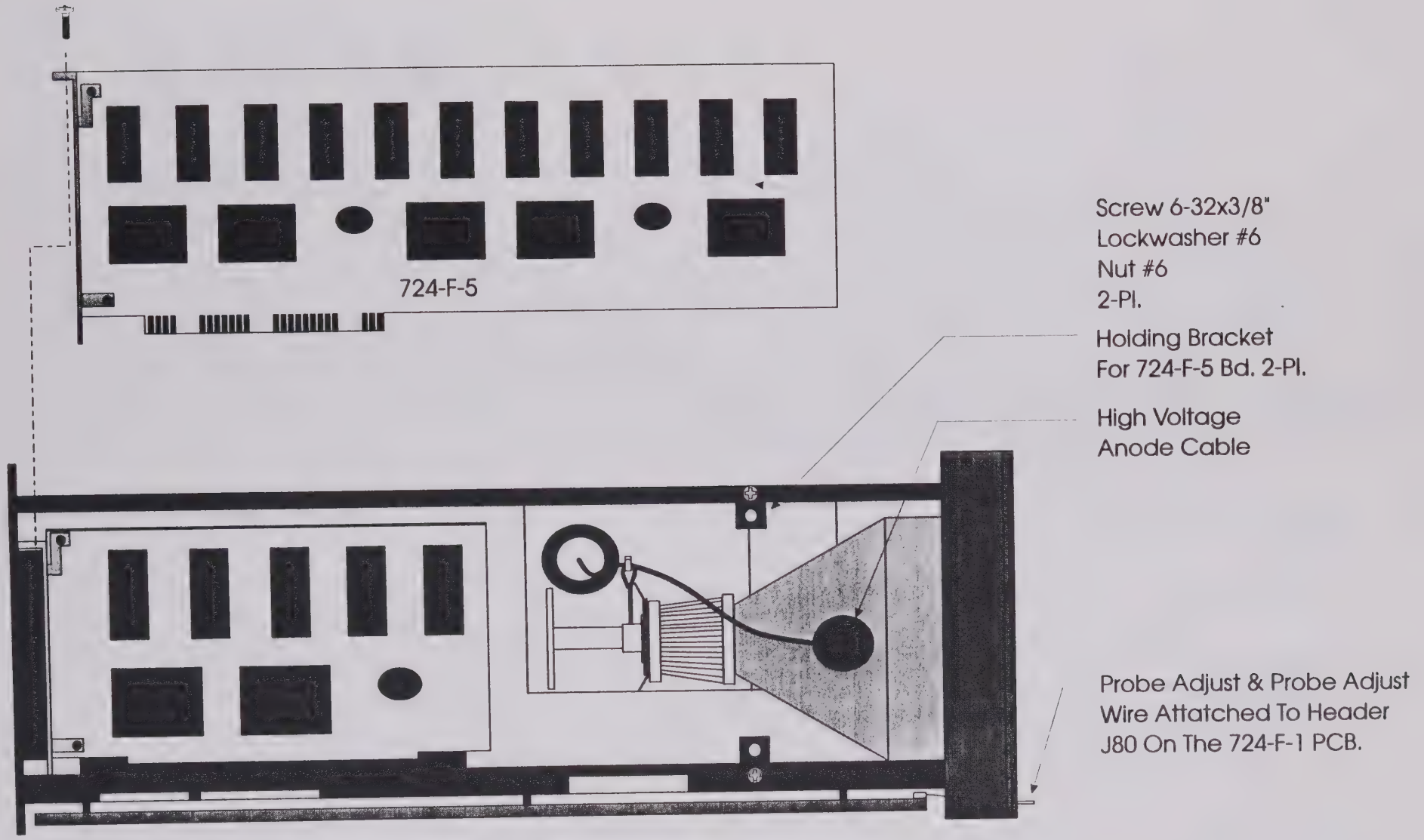


FIG 5.7 I/O BD.
INSTALLATION

Code	Qty.	Part Number	Description	Usage
A	4	560-632-006 577-600-001 575-400-002	Screw 6-32x3/8" Lockwasher #6 Flatwasher #4	Assembly Of AC/DC Power Supply To Main Chassis Assy.
B	7	580-440-002 500-090-110	Nut #4 Fiber Washer	Assembly Of Mother Bd. To Main Chassis
C	2	560-632-006 577-600-001 575-400-002	Screw 6-32x3/8" Lockwasher #6 Flatwasher #4	Assembly Of Video Card (724-F-4) To Main Chassis Assy.
D	2	560-632-006 577-600-001 581-632-002	Screw 6-32x3/8" Lockwasher #6 Nut #6	Assembly Of Video Shield To Main Chassis Assembly.

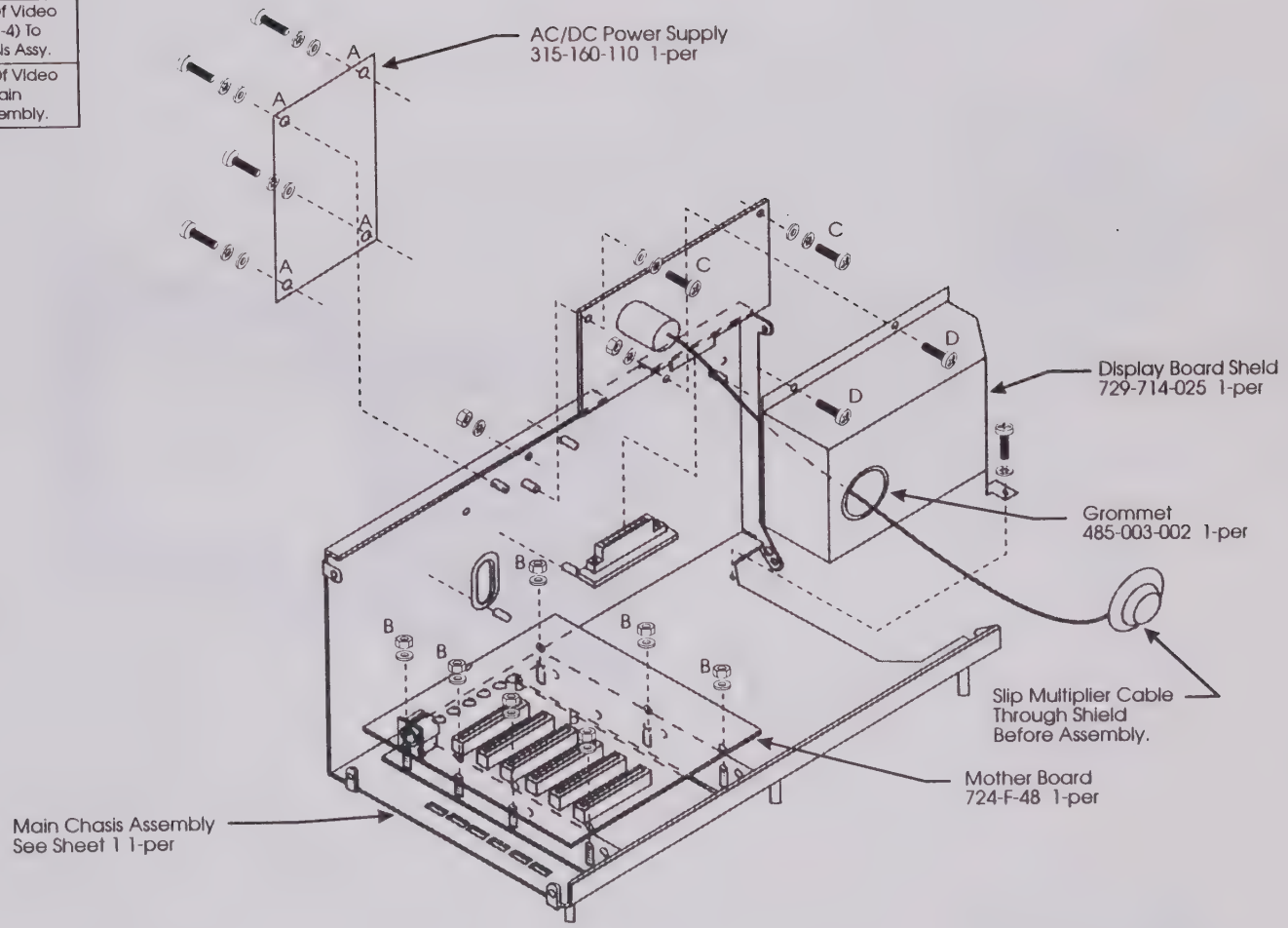


FIG 5.8 MAIN CHASSIS ASSEMBLY

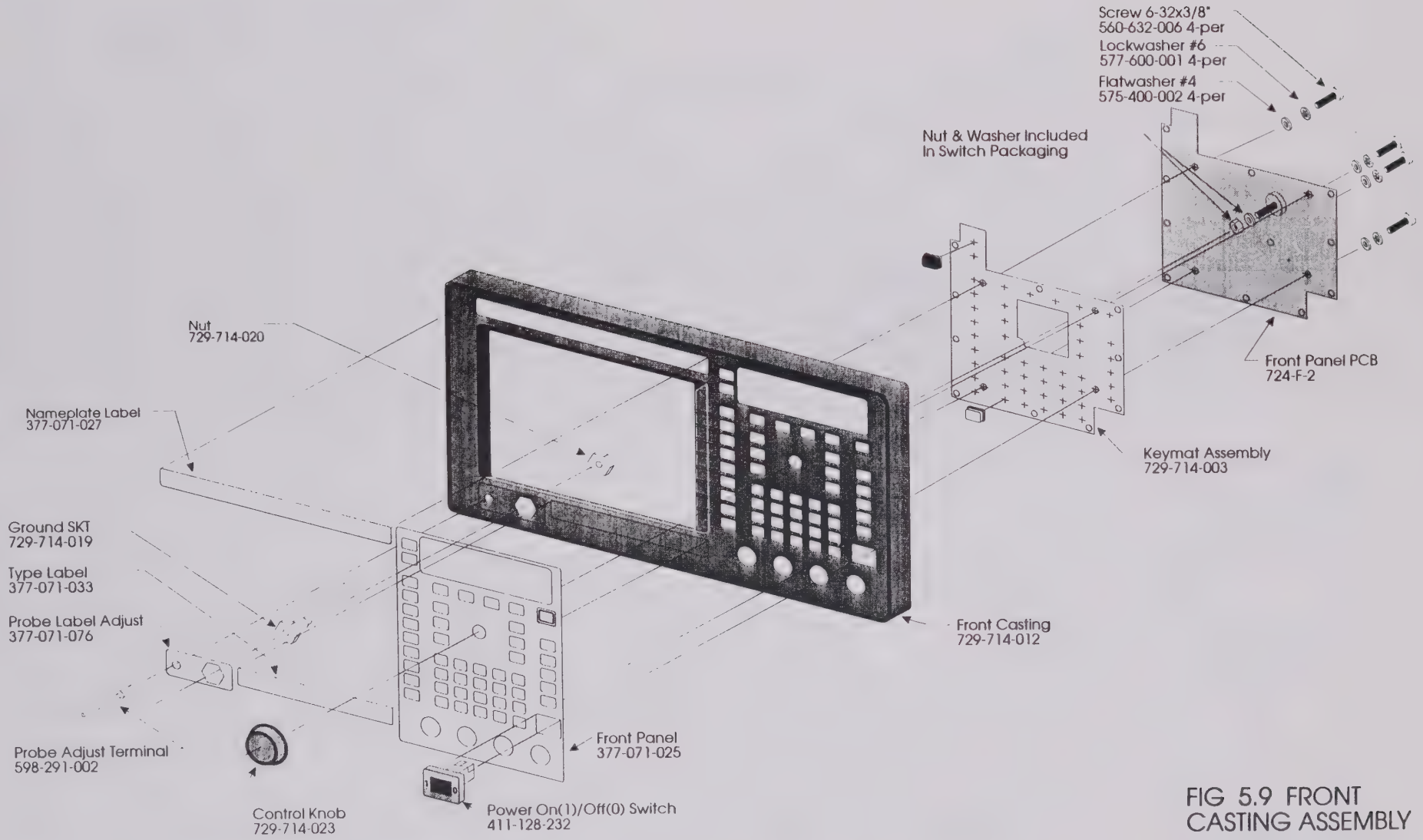


FIG 5.9 FRONT CASTING ASSEMBLY

Code	Qty.	Part Number	Description	Usage
A	2	560-440-010 575-400-002 577-400-000 577-400-001 580-440-000	Screw 4-40x5/8" Flat Washer #4 Int. Flat Wsh #4 Split. Lockwasher #4 Nut #4	Assembly Of Video Interconnect Board To Main Chassis Assembly.
B	6	568-632-004	Screw 6-32x1/4" C.S.	Attatching Mounting Plates To Main Chassis Assembly.

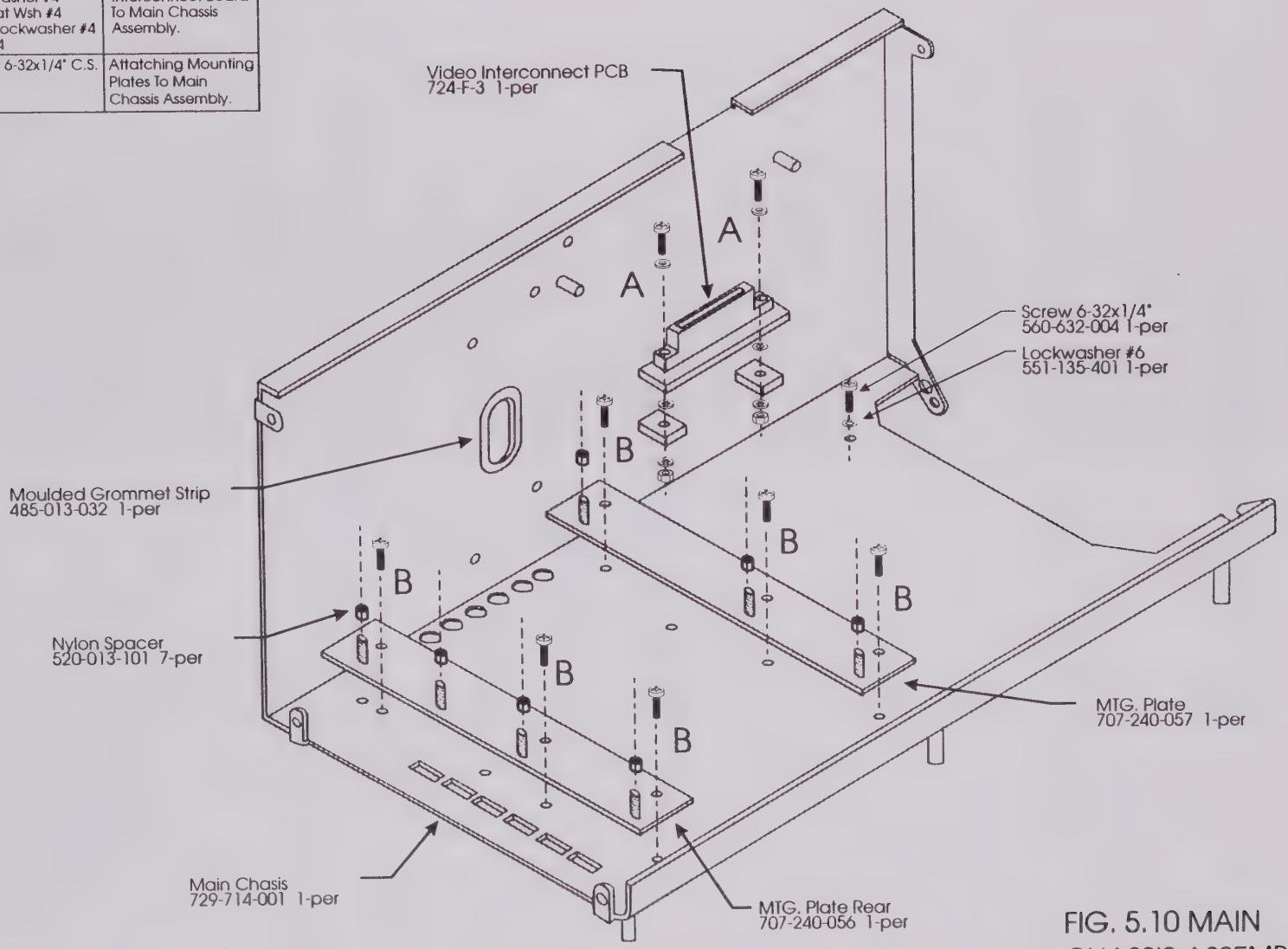


FIG. 5.10 MAIN CHASSIS ASSEMBLY

LS140 TROUBLESHOOTING

6.0 INTRODUCTION

This section will guide service personnel in troubleshooting the LS140 Digital Oscilloscope by the use of flowcharts. The section is divided into 7 parts:

1. LS140 SYSTEM
2. ACQUISITION BOARD (724-F-1)
3. I/O BOARD (724-F-5)
4. POWER SUPPLY
5. MONITOR
6. FLOPPY DISK DRIVE
7. MAIN CPU ASSEMBLY

In certain sections of the flowchart the result may be to run a commercial PC troubleshooting program. Examples of these programs are:

PROGRAM	MANUFACTURER
QAPLUS™	DIAGSOFT
AMIDIAG™	AMI CORPORATION
PC PROBE™	LANDMARK

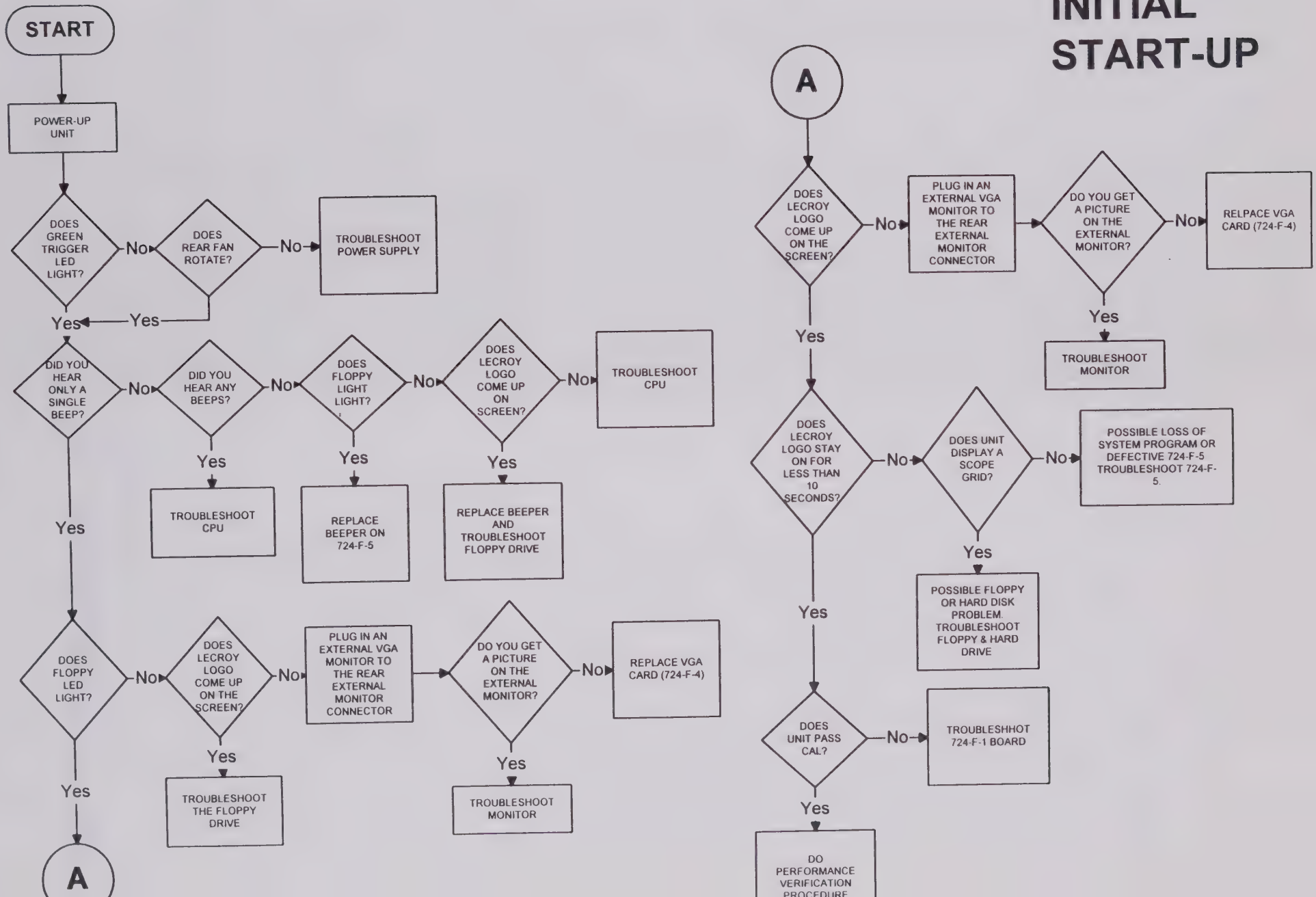
In order to use these programs the LS140 must be configured for PC mode. This is done quite easily by following the simple instructions below:

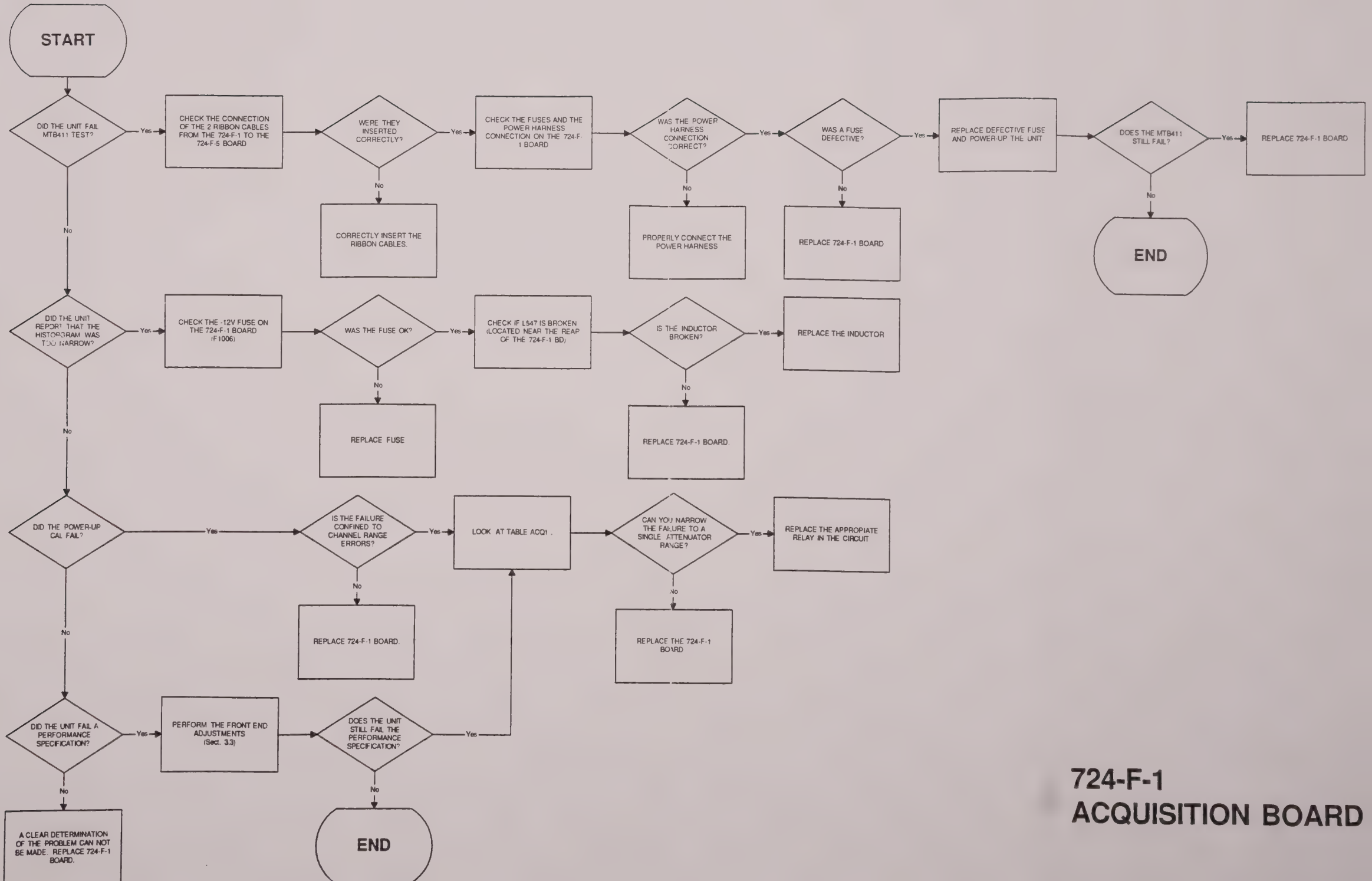
1. If the PC troubleshooting software is not contained on a "bootable" disk a DOS bootable disk must be created. Follow the instructions below to create a DOS bootable disk.
   a) Format a 3 1/2" floppy in your PC.
   b) Transfer the system boot files to the formatted floppy:
      1) If the 3 1/2" floppy drive is A: then type: SYS A: <ENTER>
      2) If the 3 1/2" floppy drive is B: then type: SYS B: <ENTER>
   c) If your PC has a DOS version of 5.0 or greater (Type: VER <ENTER>), then you are finished.
   d) If your PC has a DOS version lower that 5.0 then you must copy a file called COMMAND.COM from your PC to the formatted floppy. This file is usually in the root directory (C:\>) or in the DOS directory (C:\DOS>).

2. Remove the outer cabinet assembly from the LS140 (See Section 5.1).

3. Locate the 724-F-5 I/O card plugged into the main CPU assembly (See Section 5, Fig. 5.3).
4. Locate the 2 pin header (J5020) near the center of the 724-F-5 board.
5. Short the 2 pins of the header with a shunt.
6. Dissconnect the lower ribbon cable connected to the 724-F-1 board. It is connected to J5002 on the 724-F-5 board.
7. The system will now emulate a IBM PC/AT.
8. Place a keyboard into the AUX. CONTROLLER PORT located in the rear of the LS140.
9. Place the bootable disk into the floppy drive and turn the system on.
10. Run the diagnostic software per the manufacture's instructions.
11. When done, reverse the procedure.

INITIAL START-UP



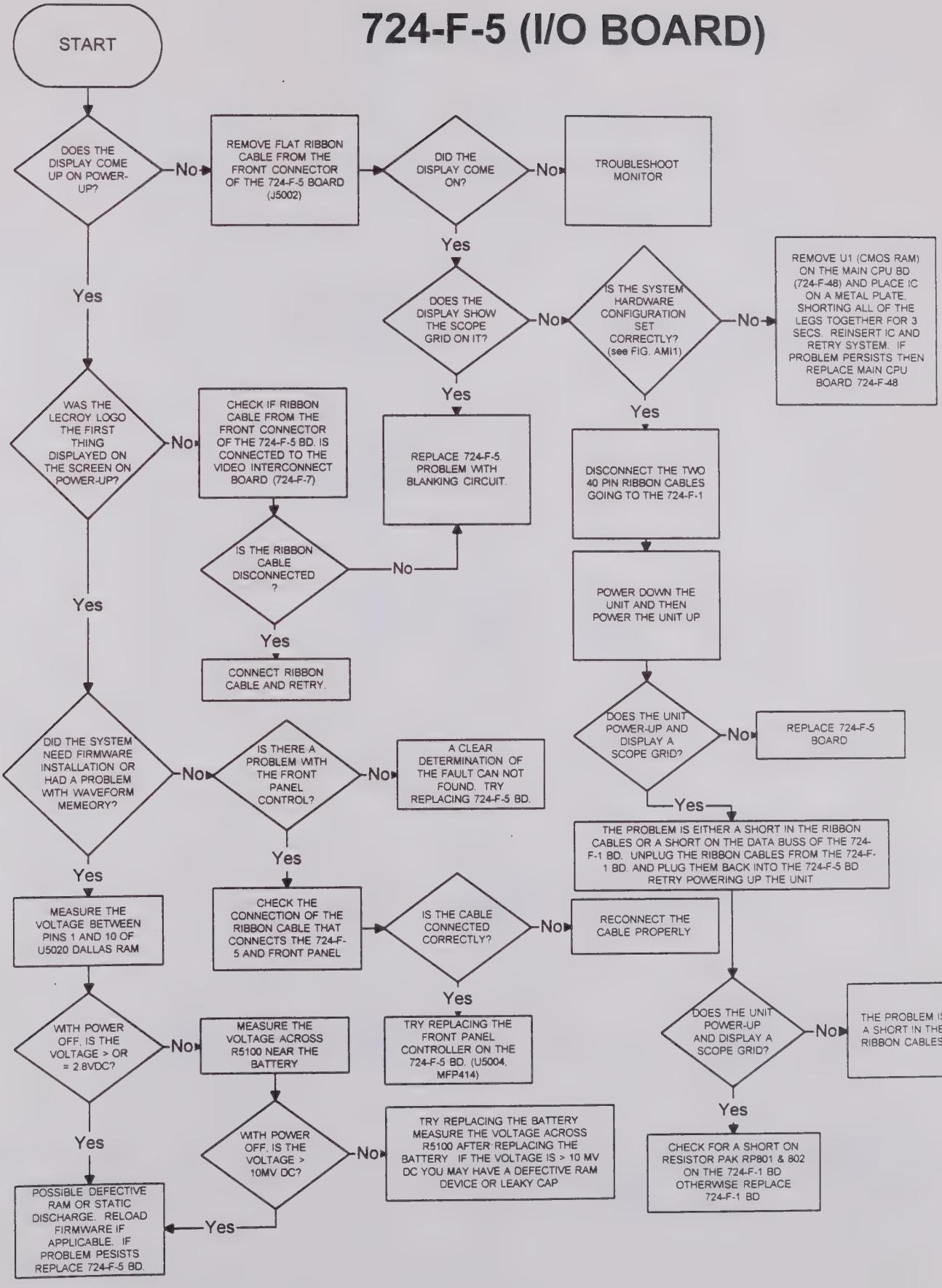


724-F-1
ACQUISITION BOARD

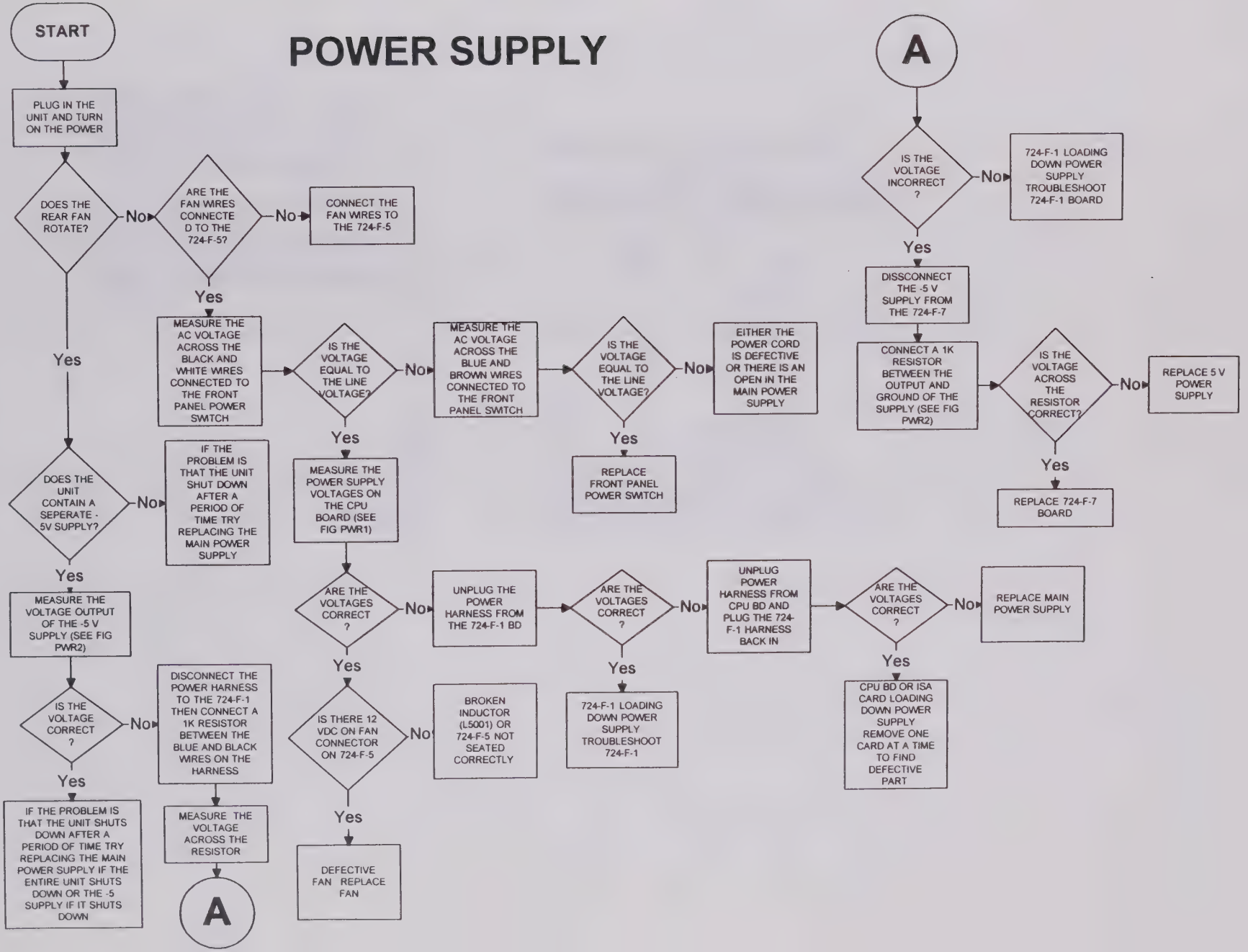
LS140 GAIN SWITCHING (TABLE ACQ1)

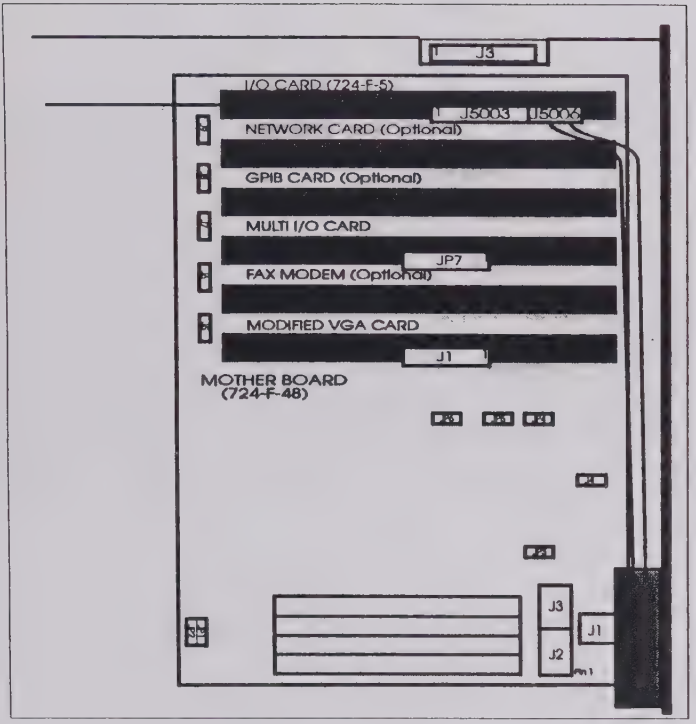
V/Div.	1st Attenuator	2nd Attenuator	1st Gain Stage	2nd Gain Stage
5m	X 1	X 1	X 5.1	X 3.85
10m	X 1	X 1	X 5	X 2.5
20m	X 1	X 1	X 5	X 1.25
50m	X 1	X 1	X 1	X 2.5
0.1	X.1	X 1	X 1	X 1.25
0.2	X.1	X 1	X 5	X 1.25
0.5	X.1	X 1	X 1	X 2.5
1	X.1	X 1	X 1	X 1.25
2	X.1	X.1	X 5	X 1.25
5	X.1	X.1	X 1	X 2.5
10	X.1	X.1	X 1	X 1.25

724-F-5 (I/O BOARD)


START
DOES THE DISPLAY COME UP ON POWER-UP?
No
REMOVE FLAT RIBBON CABLE FROM THE FRONT CONNECTOR OF THE 724-F-5 BOARD (J5002)
DID THE DISPLAY COME ON?
No
TROUBLESHOOT MONITOR
Yes
Yes
DOES THE DISPLAY SHOW THE SCOPE GRID ON IT?
No
IS THE SYSTEM HARDWARE CONFIGURATION SET CORRECTLY? (see FIG. AMI1)
No
REMOVE U1 (CMOS RAM) ON THE MAIN CPU BD (724-F-48) AND PLACE IC ON A METAL PLATE. SHORTING ALL OF THE LEGS TOGETHER FOR 3 SECS. REINSERT IC AND RETRY SYSTEM. IF PROBLEM PERSISTS THEN REPLACE MAIN CPU BOARD 724-F-48
Yes
Yes
WAS THE LECROY LOGO THE FIRST THING DISPLAYED ON THE SCREEN ON POWER-UP?
No
CHECK IF RIBBON CABLE FROM THE FRONT CONNECTOR OF THE 724-F-5 BD. IS CONNECTED TO THE VIDEO INTERCONNECT BOARD (724-F-7)
REPLACE 724-F-5. PROBLEM WITH BLANKING CIRCUIT.
DISCONNECT THE TWO 40 PIN RIBBON CABLES GOING TO THE 724-F-1
IS THE RIBBON CABLE DISCONNECTED ?
No
Yes
CONNECT RIBBON CABLE AND RETRY.
POWER DOWN THE UNIT AND THEN POWER THE UNIT UP
Yes
DID THE SYSTEM NEED FIRMWARE INSTALLATION OR HAD A PROBLEM WITH WAVEFORM MEMEORY?
No
IS THERE A PROBLEM WITH THE FRONT PANEL CONTROL?
No
A CLEAR DETERMINATION OF THE FAULT CAN NOT FOUND. TRY REPLACING 724-F-5 BD.
DOES THE UNIT POWER-UP AND DISPLAY A SCOPE GRID?
No
REPLACE 724-F-5 BOARD
Yes
Yes
THE PROBLEM IS EITHER A SHORT IN THE RIBBON CABLES OR A SHORT ON THE DATA BUSS OF THE 724-F-1 BD. UNPLUG THE RIBBON CABLES FROM THE 724-F-1 BD. AND PLUG THEM BACK INTO THE 724-F-5 BD RETRY POWERING UP THE UNIT
Yes
MEASURE THE VOLTAGE BETWEEN PINS 1 AND 10 OF U5020 DALLAS RAM
CHECK THE CONNECTION OF THE RIBBON CABLE THAT CONNECTS THE 724-F-5 AND FRONT PANEL
IS THE CABLE CONNECTED CORRECTLY?
No
RECONNECT THE CABLE PROPERLY
Yes
TRY REPLACING THE FRONT PANEL CONTROLLER ON THE 724-F-5 BD. (U5004, MFP414)
WITH POWER OFF, IS THE VOLTAGE > OR = 2.8VDC?
No
MEASURE THE VOLTAGE ACROSS R5100 NEAR THE BATTERY
DOES THE UNIT POWER-UP AND DISPLAY A SCOPE GRID?
No
THE PROBLEM IS A SHORT IN THE RIBBON CABLES
Yes
Yes
WITH POWER OFF, IS THE VOLTAGE > 10MV DC?
No
TRY REPLACING THE BATTERY MEASURE THE VOLTAGE ACROSS R5100 AFTER REPLACING THE BATTERY IF THE VOLTAGE IS > 10 MV DC YOU MAY HAVE A DEFECTIVE RAM DEVICE OR LEAKY CAP
CHECK FOR A SHORT ON RESISTOR PAK RP801 & 802 ON THE 724-F-1 BD OTHERWISE REPLACE 724-F-1 BD
Yes
POSSIBLE DEFECTIVE RAM OR STATIC DISCHARGE. RELOAD FIRMWARE IF APPLICABLE. IF PROBLEM PESISTS REPLACE 724-F-5 BD.

POWER SUPPLY


START
PLUG IN THE UNIT AND TURN ON THE POWER
DOES THE REAR FAN ROTATE?
No
ARE THE FAN WIRES CONNECTE D TO THE 724-F-5?
No
CONNECT THE FAN WIRES TO THE 724-F-5
Yes
MEASURE THE AC VOLTAGE ACROSS THE BLACK AND WHITE WIRES CONNECTED TO THE FRONT PANEL POWER SWITCH
IS THE VOLTAGE EQUAL TO THE LINE VOLTAGE?
No
MEASURE THE AC VOLTAGE ACROSS THE BLUE AND BROWN WIRES CONNECTED TO THE FRONT PANEL SWITCH
IS THE VOLTAGE EQUAL TO THE LINE VOLTAGE?
No
EITHER THE POWER CORD IS DEFECTIVE OR THERE IS AN OPEN IN THE MAIN POWER SUPPLY
Yes
REPLACE FRONT PANEL POWER SWITCH
Yes
MEASURE THE POWER SUPPLY VOLTAGES ON THE CPU BOARD (SEE FIG PWR1)
ARE THE VOLTAGES CORRECT ?
No
UNPLUG THE POWER HARNESS FROM THE 724-F-1 BD
ARE THE VOLTAGES CORRECT ?
No
UNPLUG POWER HARNESS FROM CPU BD AND PLUG THE 724-F-1 HARNESS BACK IN
ARE THE VOLTAGES CORRECT ?
No
REPLACE MAIN POWER SUPPLY
Yes
CPU BD OR ISA CARD LOADING DOWN POWER SUPPLY REMOVE ONE CARD AT A TIME TO FIND DEFECTIVE PART
Yes
724-F-1 LOADING DOWN POWER SUPPLY TROUBLESHOOT 724-F-1
Yes
IS THERE 12 VDC ON FAN CONNECTOR ON 724-F-5
No
BROKEN INDUCTOR (L5001) OR 724-F-5 NOT SEATED CORRECTLY
Yes
DEFECTIVE FAN REPLACE FAN
Yes
DOES THE UNIT CONTAIN A SEPERATE -5V SUPPLY?
No
IF THE PROBLEM IS THAT THE UNIT SHUT DOWN AFTER A PERIOD OF TIME TRY REPLACING THE MAIN POWER SUPPLY
Yes
MEASURE THE VOLTAGE OUTPUT OF THE -5 V SUPPLY (SEE FIG PWR2)
IS THE VOLTAGE CORRECT ?
No
DISCONNECT THE POWER HARNESS TO THE 724-F-1 THEN CONNECT A 1K RESISTOR BETWEEN THE BLUE AND BLACK WIRES ON THE HARNESS
MEASURE THE VOLTAGE ACROSS THE RESISTOR
A
Yes
IF THE PROBLEM IS THAT THE UNIT SHUTS DOWN AFTER A PERIOD OF TIME TRY REPLACING THE MAIN POWER SUPPLY IF THE ENTIRE UNIT SHUTS DOWN OR THE -5 SUPPLY IF IT SHUTS DOWN
A
IS THE VOLTAGE INCORRECT ?
No
724-F-1 LOADING DOWN POWER SUPPLY TROUBLESHOOT 724-F-1 BOARD
Yes
DISSCONNECT THE -5 V SUPPLY FROM THE 724-F-7
CONNECT A 1K RESISTOR BETWEEN THE OUTPUT AND GROUND OF THE SUPPLY (SEE FIG PWR2)
IS THE VOLTAGE ACROSS THE RESISTOR CORRECT?
No
REPLACE 5 V POWER SUPPLY
Yes
REPLACE 724-F-7 BOARD



POWER CONNECTOR J2&J3

PIN	ASSIGNMENT	COLOR
1	POWERGOOD	ORANGE
2	+5V	RED
3	+12V	YELLOW
4	-12V	BLUE
5	GND	BLACK
6	GND	BLACK
7	GND	BLACK
8	GND	BLACK
9	-5V	WHITE
10	+5V	RED
11	+5V	RED
12	+5V	RED

FIG. PWR1

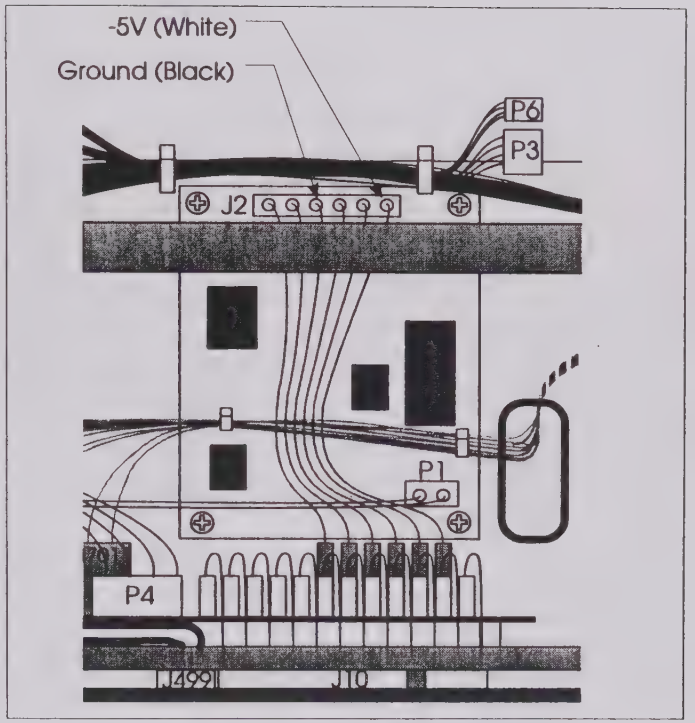
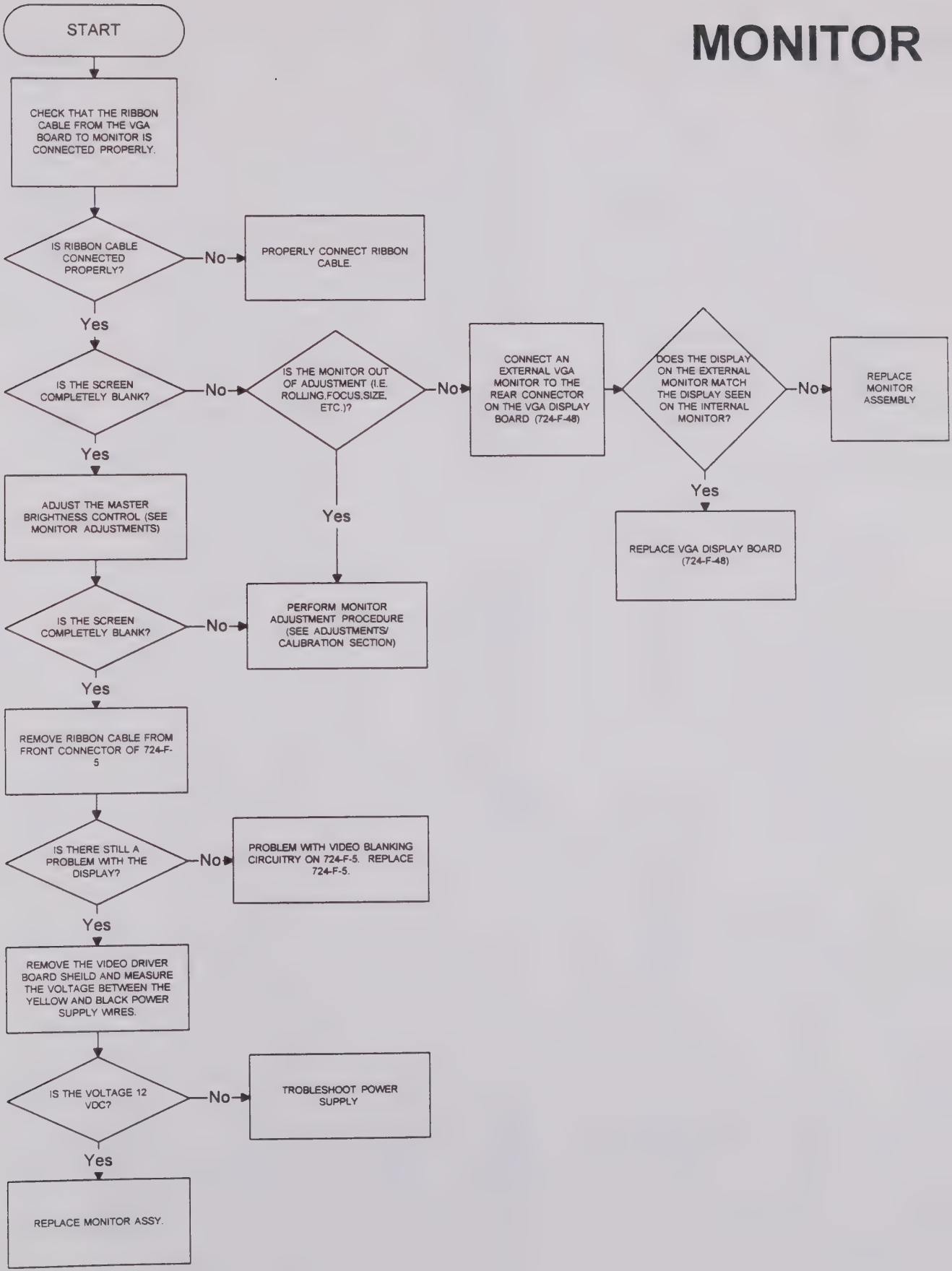
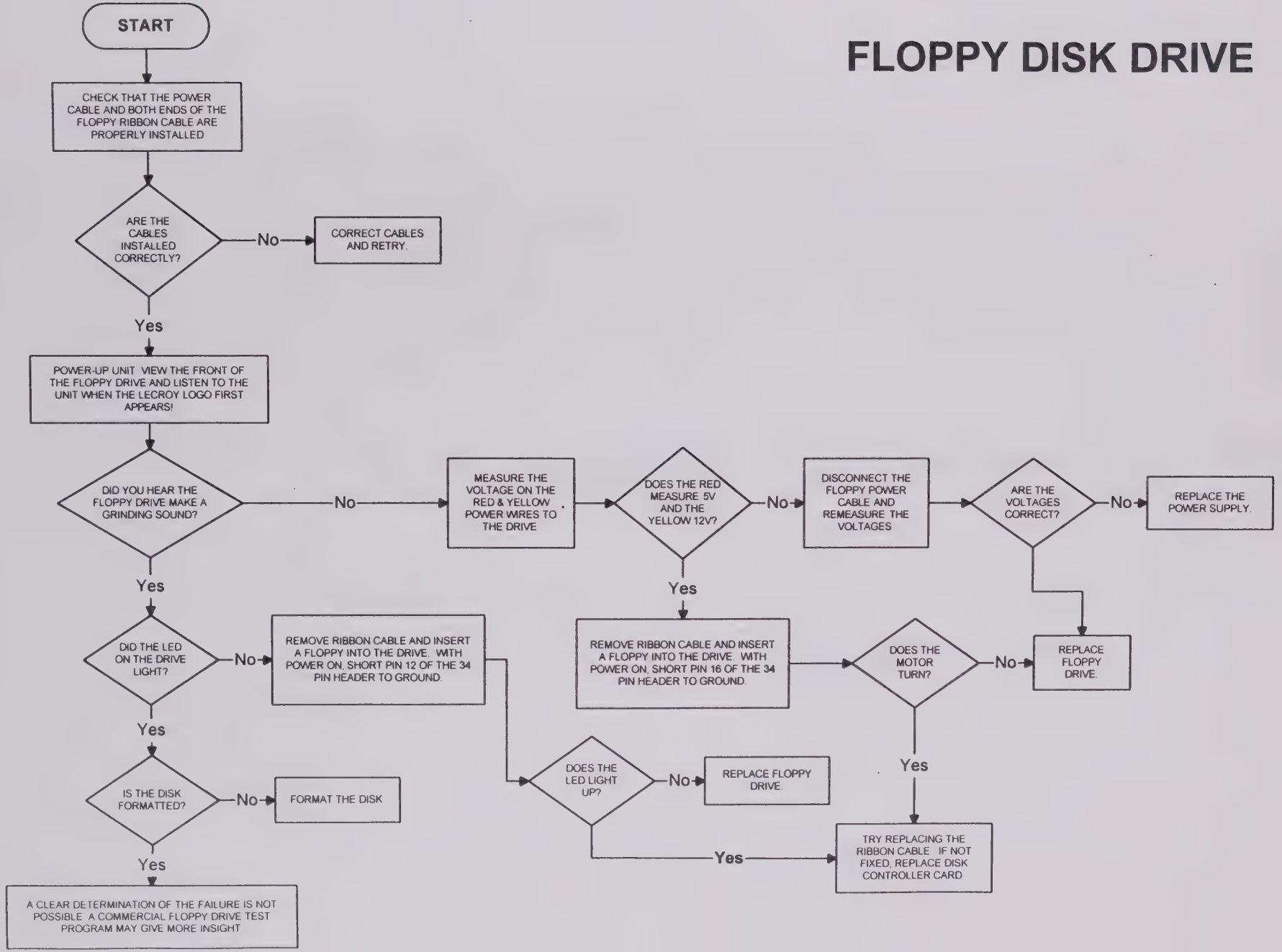


FIG. PWR2

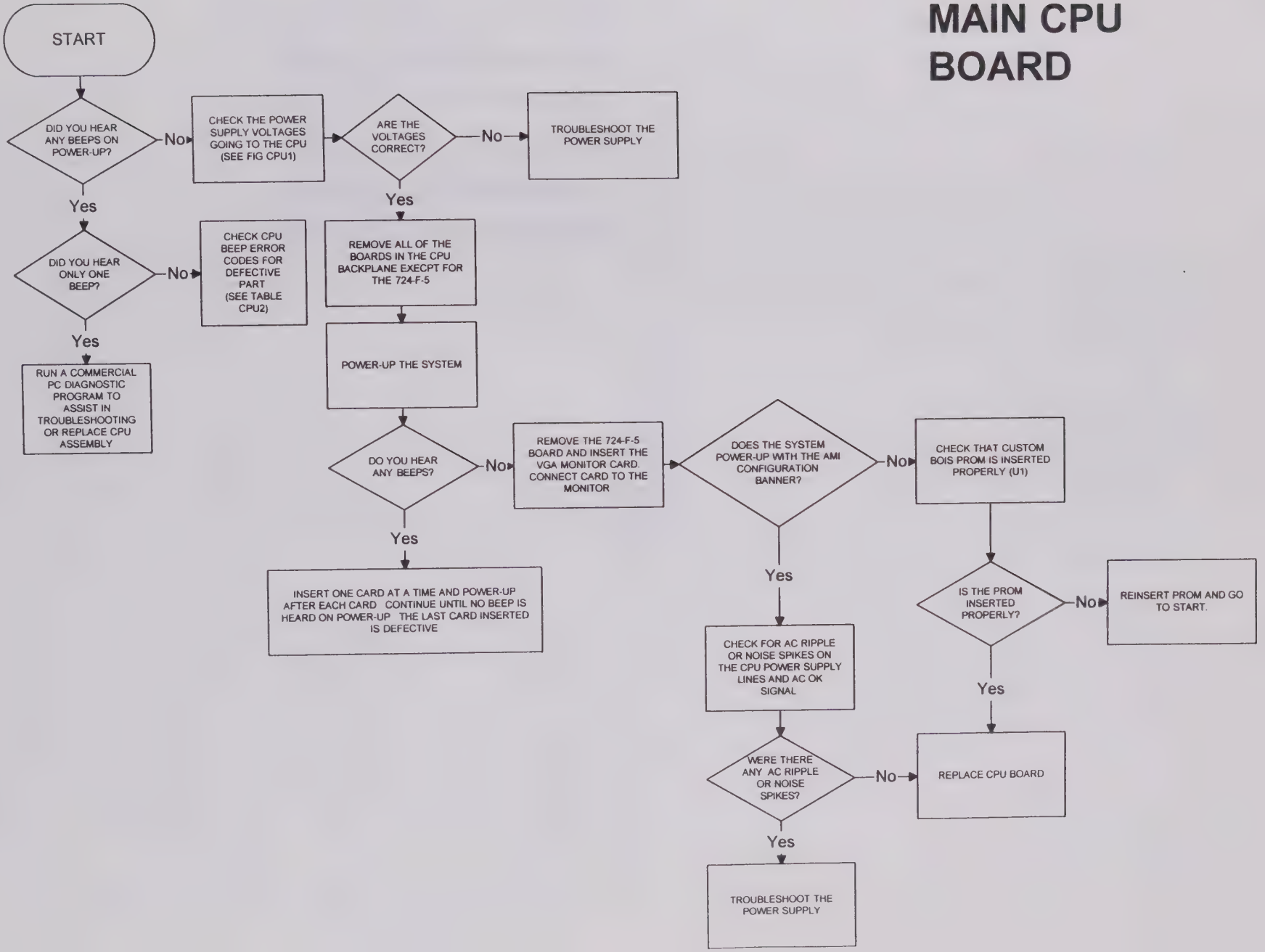
MONITOR

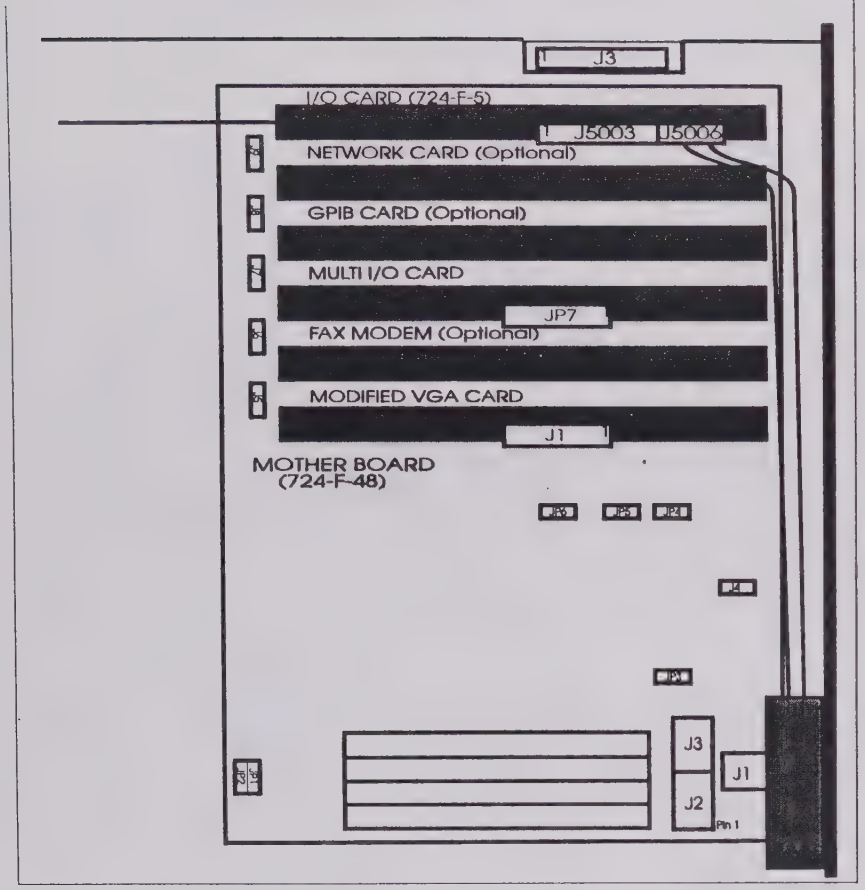

START
CHECK THAT THE RIBBON CABLE FROM THE VGA BOARD TO MONITOR IS CONNECTED PROPERLY.
IS RIBBON CABLE CONNECTED PROPERLY?
No
PROPERLY CONNECT RIBBON CABLE.
Yes
IS THE SCREEN COMPLETELY BLANK?
No
IS THE MONITOR OUT OF ADJUSTMENT (I.E. ROLLING,FOCUS,SIZE, ETC.)?
No
CONNECT AN EXTERNAL VGA MONITOR TO THE REAR CONNECTOR ON THE VGA DISPLAY BOARD (724-F-48)
DOES THE DISPLAY ON THE EXTERNAL MONITOR MATCH THE DISPLAY SEEN ON THE INTERNAL MONITOR?
No
REPLACE MONITOR ASSEMBLY
Yes
REPLACE VGA DISPLAY BOARD (724-F-48)
Yes
ADJUST THE MASTER BRIGHTNESS CONTROL (SEE MONITOR ADJUSTMENTS)
Yes
IS THE SCREEN COMPLETELY BLANK?
No
PERFORM MONITOR ADJUSTMENT PROCEDURE (SEE ADJUSTMENTS/ CALIBRATION SECTION)
Yes
REMOVE RIBBON CABLE FROM FRONT CONNECTOR OF 724-F-5
IS THERE STILL A PROBLEM WITH THE DISPLAY?
No
PROBLEM WITH VIDEO BLANKING CIRCUITRY ON 724-F-5. REPLACE 724-F-5.
Yes
REMOVE THE VIDEO DRIVER BOARD SHEILD AND MEASURE THE VOLTAGE BETWEEN THE YELLOW AND BLACK POWER SUPPLY WIRES.
IS THE VOLTAGE 12 VDC?
No
TROBLESHOOT POWER SUPPLY
Yes
REPLACE MONITOR ASSY.

FLOPPY DISK DRIVE


START
CHECK THAT THE POWER CABLE AND BOTH ENDS OF THE FLOPPY RIBBON CABLE ARE PROPERLY INSTALLED
ARE THE CABLES INSTALLED CORRECTLY?
No
CORRECT CABLES AND RETRY.
Yes
POWER-UP UNIT VIEW THE FRONT OF THE FLOPPY DRIVE AND LISTEN TO THE UNIT WHEN THE LECROY LOGO FIRST APPEARS!
DID YOU HEAR THE FLOPPY DRIVE MAKE A GRINDING SOUND?
No
MEASURE THE VOLTAGE ON THE RED & YELLOW POWER WIRES TO THE DRIVE
DOES THE RED MEASURE 5V AND THE YELLOW 12V?
No
DISCONNECT THE FLOPPY POWER CABLE AND REMEASURE THE VOLTAGES
ARE THE VOLTAGES CORRECT?
No
REPLACE THE POWER SUPPLY.
Yes
Yes
DID THE LED ON THE DRIVE LIGHT?
No
REMOVE RIBBON CABLE AND INSERT A FLOPPY INTO THE DRIVE. WITH POWER ON, SHORT PIN 12 OF THE 34 PIN HEADER TO GROUND.
REMOVE RIBBON CABLE AND INSERT A FLOPPY INTO THE DRIVE. WITH POWER ON, SHORT PIN 16 OF THE 34 PIN HEADER TO GROUND.
DOES THE MOTOR TURN?
No
REPLACE FLOPPY DRIVE.
Yes
Yes
IS THE DISK FORMATTED?
No
FORMAT THE DISK
DOES THE LED LIGHT UP?
No
REPLACE FLOPPY DRIVE.
Yes
Yes
TRY REPLACING THE RIBBON CABLE IF NOT FIXED, REPLACE DISK CONTROLLER CARD
A CLEAR DETERMINATION OF THE FAILURE IS NOT POSSIBLE A COMMERCIAL FLOPPY DRIVE TEST PROGRAM MAY GIVE MORE INSIGHT

MAIN CPU BOARD


START
DID YOU HEAR ANY BEEPS ON POWER-UP?
No
CHECK THE POWER SUPPLY VOLTAGES GOING TO THE CPU (SEE FIG CPU1)
ARE THE VOLTAGES CORRECT?
No
TROUBLESHOOT THE POWER SUPPLY
Yes
Yes
DID YOU HEAR ONLY ONE BEEP?
No
CHECK CPU BEEP ERROR CODES FOR DEFECTIVE PART (SEE TABLE CPU2)
REMOVE ALL OF THE BOARDS IN THE CPU BACKPLANE EXECPT FOR THE 724-F-5
Yes
RUN A COMMERCIAL PC DIAGNOSTIC PROGRAM TO ASSIST IN TROUBLESHOOTING OR REPLACE CPU ASSEMBLY
POWER-UP THE SYSTEM
DO YOU HEAR ANY BEEPS?
No
REMOVE THE 724-F-5 BOARD AND INSERT THE VGA MONITOR CARD. CONNECT CARD TO THE MONITOR
DOES THE SYSTEM POWER-UP WITH THE AMI CONFIGURATION BANNER?
No
CHECK THAT CUSTOM BOIS PROM IS INSERTED PROPERLY (U1)
Yes
INSERT ONE CARD AT A TIME AND POWER-UP AFTER EACH CARD CONTINUE UNTIL NO BEEP IS HEARD ON POWER-UP THE LAST CARD INSERTED IS DEFECTIVE
Yes
CHECK FOR AC RIPPLE OR NOISE SPIKES ON THE CPU POWER SUPPLY LINES AND AC OK SIGNAL
IS THE PROM INSERTED PROPERLY?
No
REINSERT PROM AND GO TO START.
Yes
WERE THERE ANY AC RIPPLE OR NOISE SPIKES?
No
REPLACE CPU BOARD
Yes
TROUBLESHOOT THE POWER SUPPLY



POWER CONNECTOR J2&J3

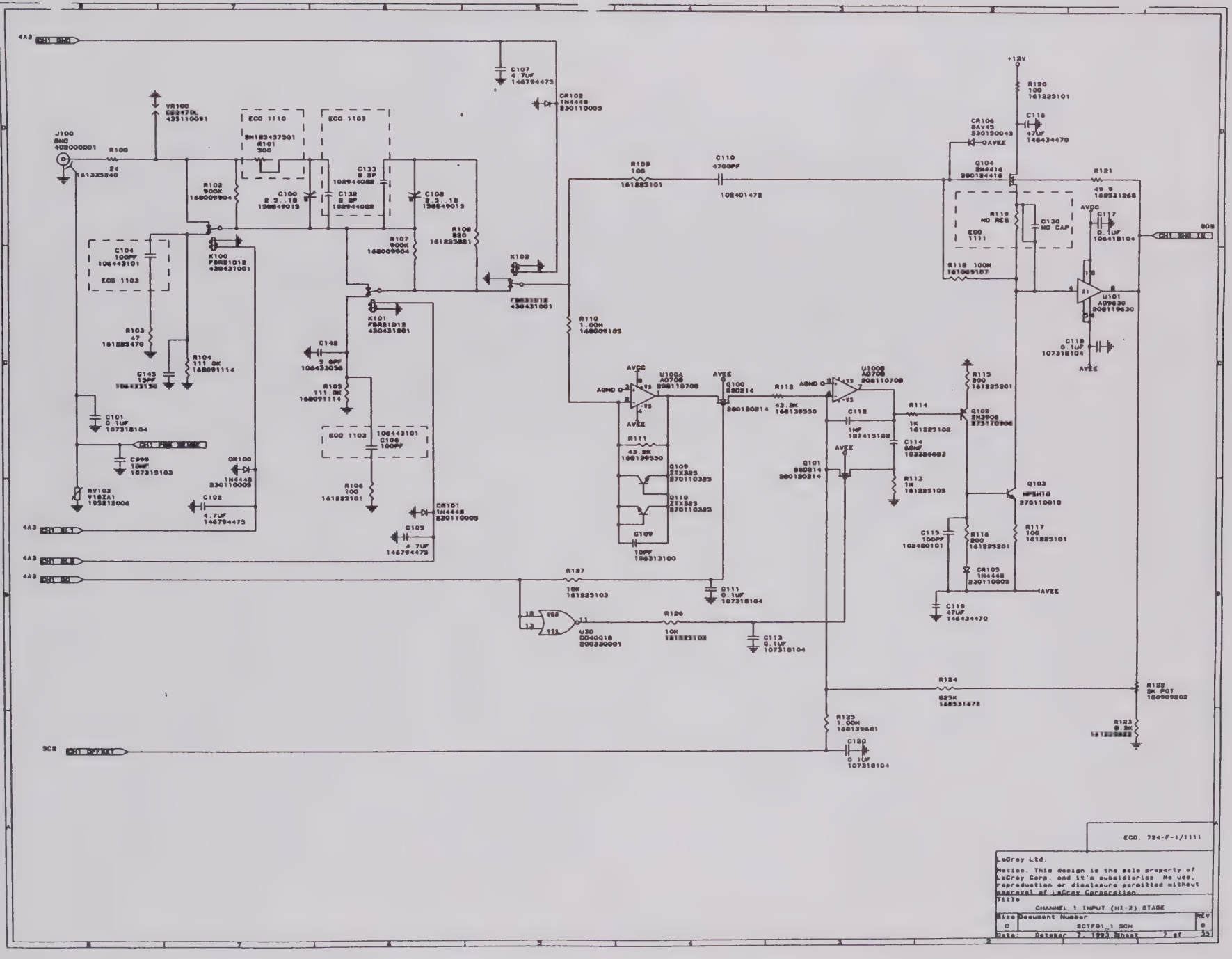
PIN	ASSIGNMENT	COLOR
1	POWERGOOD	ORANGE
2	+5V	RED
3	+12V	YELLOW
4	-12V	BLUE
5	GND	BLACK
6	GND	BLACK
7	GND	BLACK
8	GND	BLACK
9	-5V	WHITE
10	+5V	RED
11	+5V	RED
12	+5V	RED

FIG CPU1

BIOS ERROR BEEP CODES

No. of Beeps	Error Message
1	Refresh Failure
2	Parity Error
3	Base 64KB Memory Failure
4	Display Memory Read/Write Error
5	Processor Error
6	8042-Gate A20 Failure
7	Processor Exception Interrupt Error

TABLE CPU2


ECO. 724-F-1/1111
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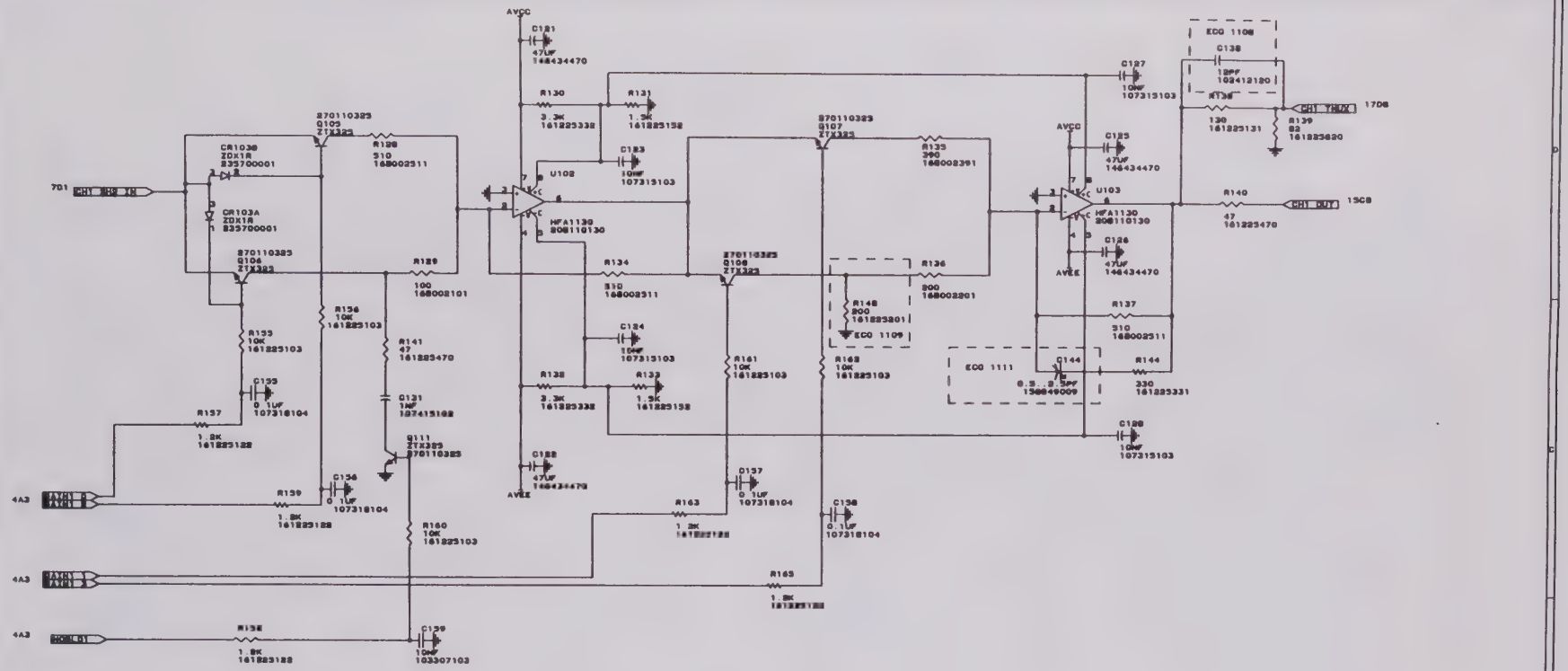
Title
CHANNEL 1 INPUT (HI-Z) STAGE
Size Document Number
C
SC7F01_1.SCH
REV
B
Date: October 7, 1993 Sheet 7 of 33



MOBLO	GAIN_0	GAIN_1	GAIN_2	GAIN_3	SELECTION	RANGE
1	0	0	1	1	0.3	100mV 1V 10V
1	0	1	1	0	3	300mV 3V
0	1	0	0	1	10.3	800mV 8V
0	1	1	0	0	33	10mV
0	1	1	0	1	1	3mV
1	0	0	0	0	DESELECTED	

ECO: 784-F-1/1111

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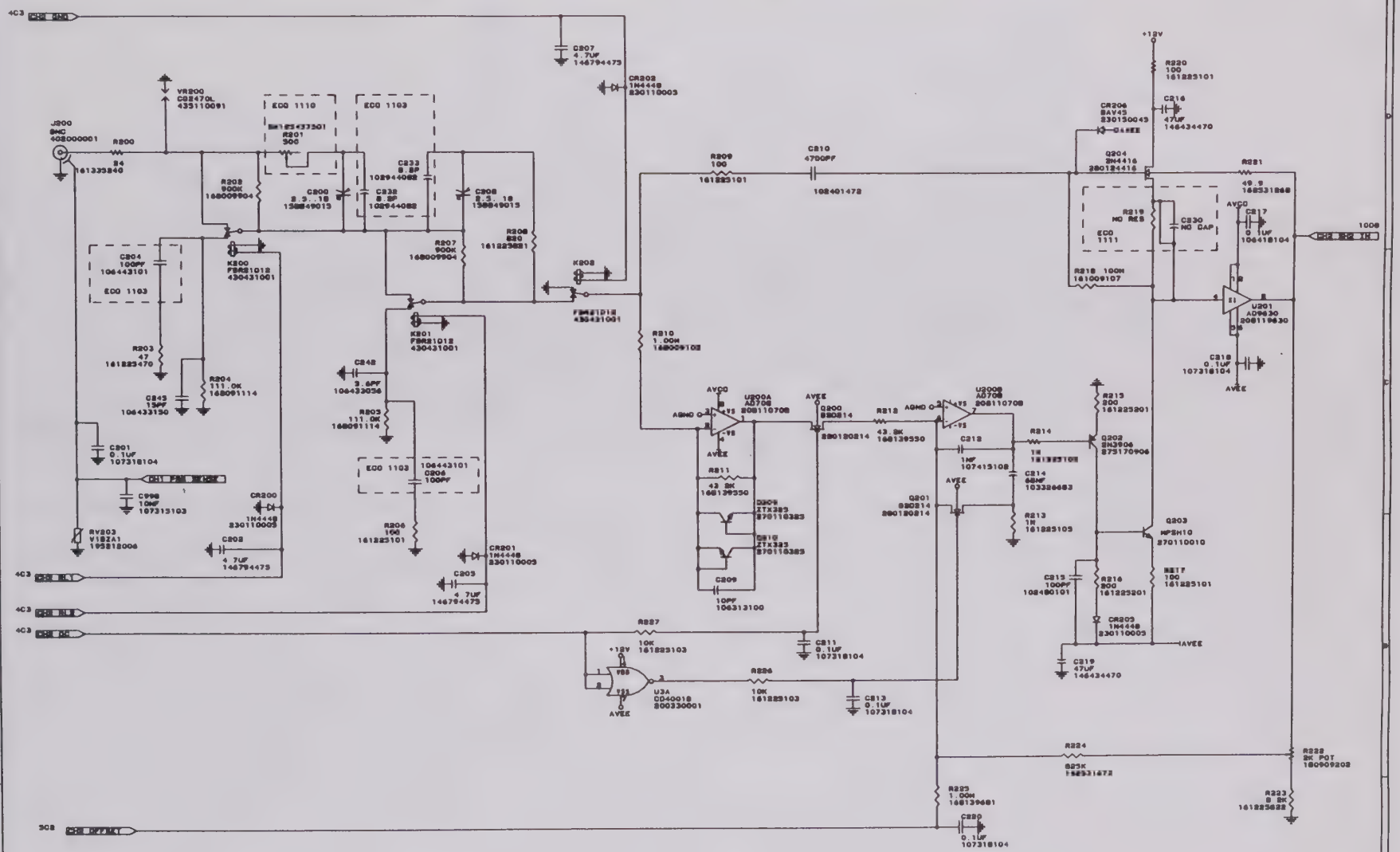
Title: CHANNEL 1 SECOND STAGE

Size	Document Number	REV
C	SCTF01_2.SCH	B

Date: October 8, 1993 Sheet 8 of 33


ECO. 784-F-1/1111
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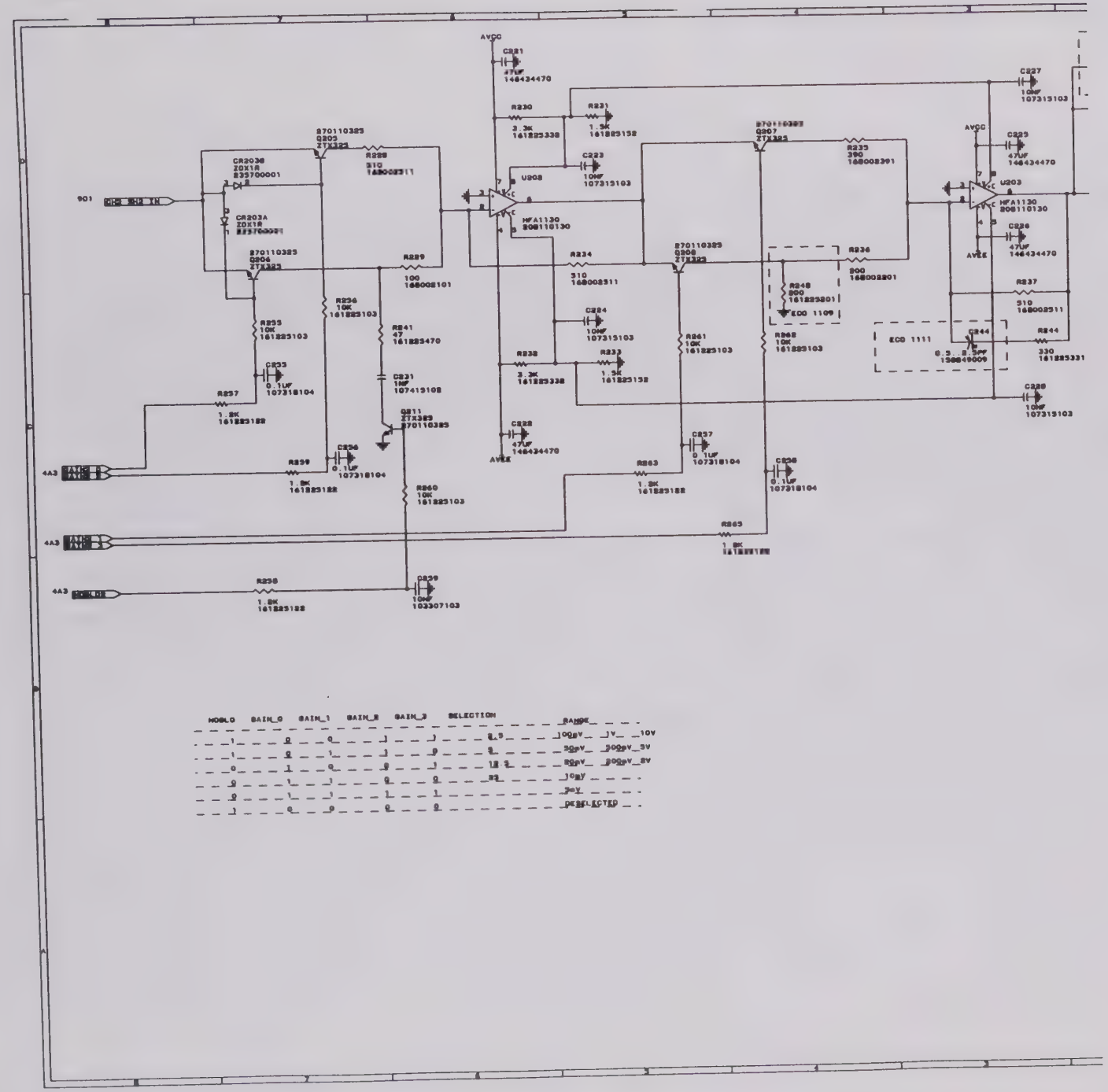
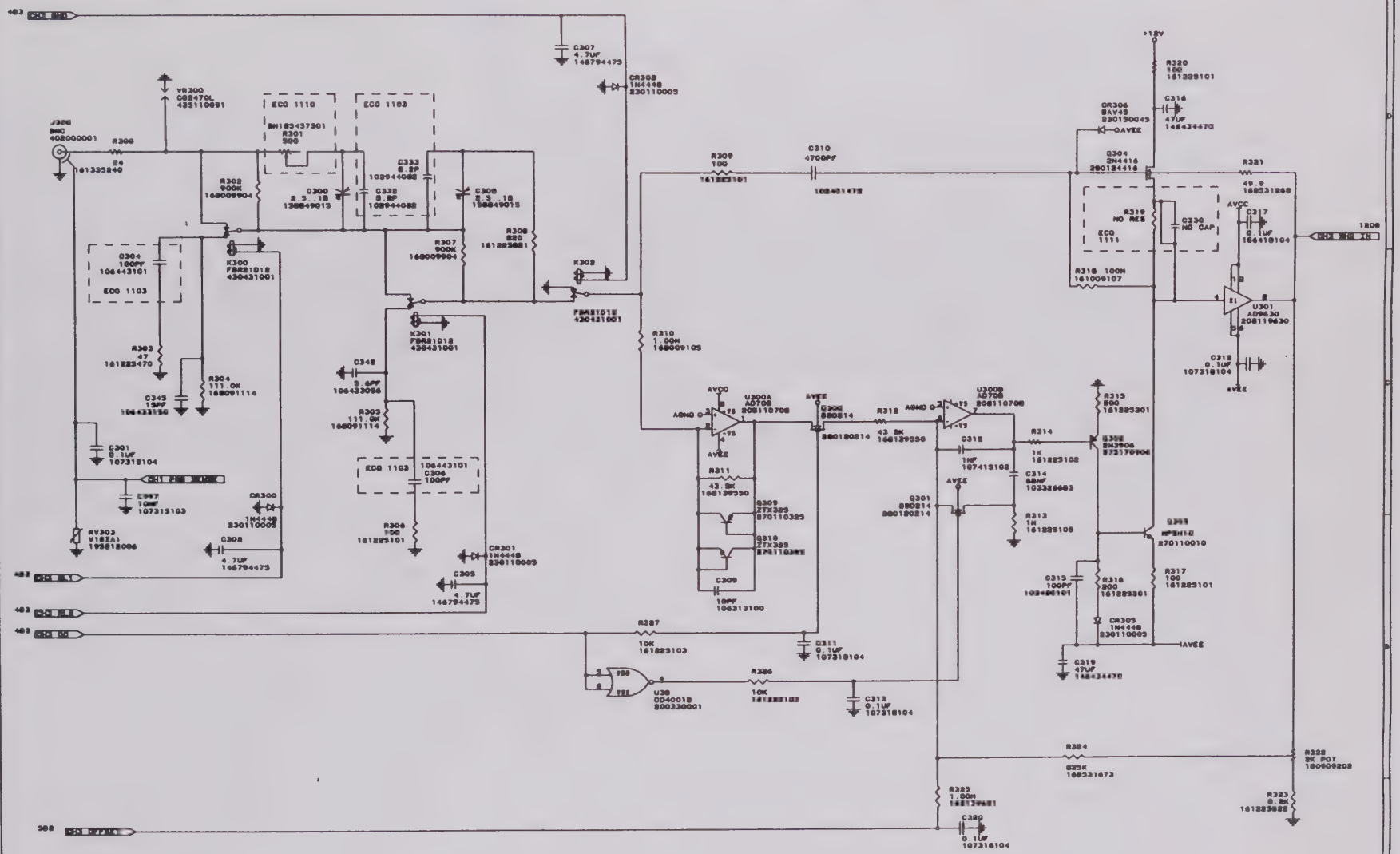
Title
CHANNEL B INPUT (HI-Z) STAGE
Size C
Document Number SCTF08_1.SCH
REV B
Date: October 7, 1993 Sheet 9 of 33



MODLO	GAIN_0	GAIN_1	GAIN_2	GAIN_3	SELECTION	RANGE		
1	0	0	1	1	0.5	100mV	1V	10V
1	0	1	1	0	5	500mV	500mV	5V
0	1	0	0	1	10.5	500mV	500mV	8V
0	1	1	0	0	85	10mV		
0	1	1	1	1	1	5mV		
1	0	0	0	0		DESELECTED		


ECO: 784-F-1/1111
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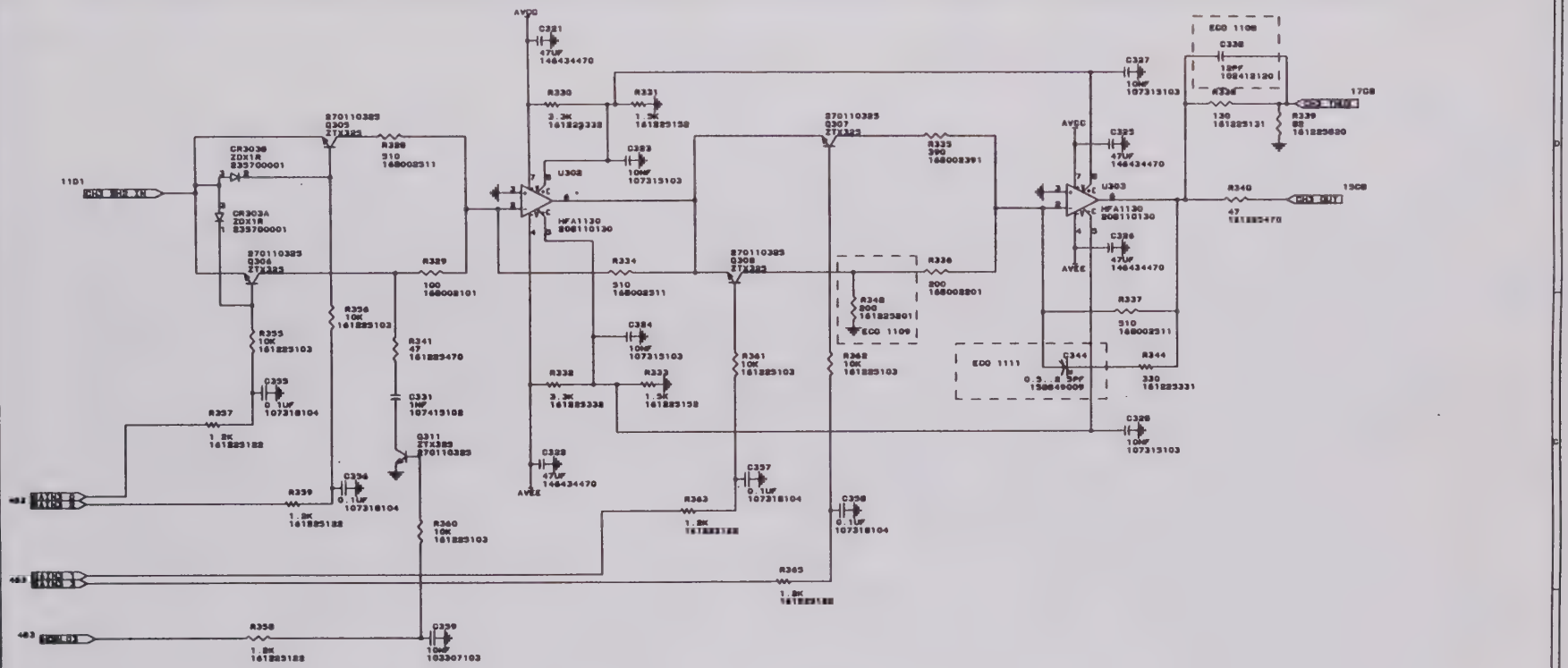
Title
CHANNEL 3 INPUT (HI-Z) STAGE
Size Document Number REV
C SCTF03_1.SCH B
Date: October 7, 1993 Sheet 11 of 33



MODLO	GAIN_0	GAIN_1	GAIN_2	GAIN_3	SELECTION	RANGE
1	0	0	1	1	6.3	100mV 1V 10V
1	0	1	1	0	2	300mV 1000mV 3V
0	1	0	0	1	12.2	800mV 8000mV 8V
0	1	1	0	0	63	100mV
0	1	1	1	1		1mV
1	0	0	0	0	DEFECTED	

ECO: 726-F-1/1111

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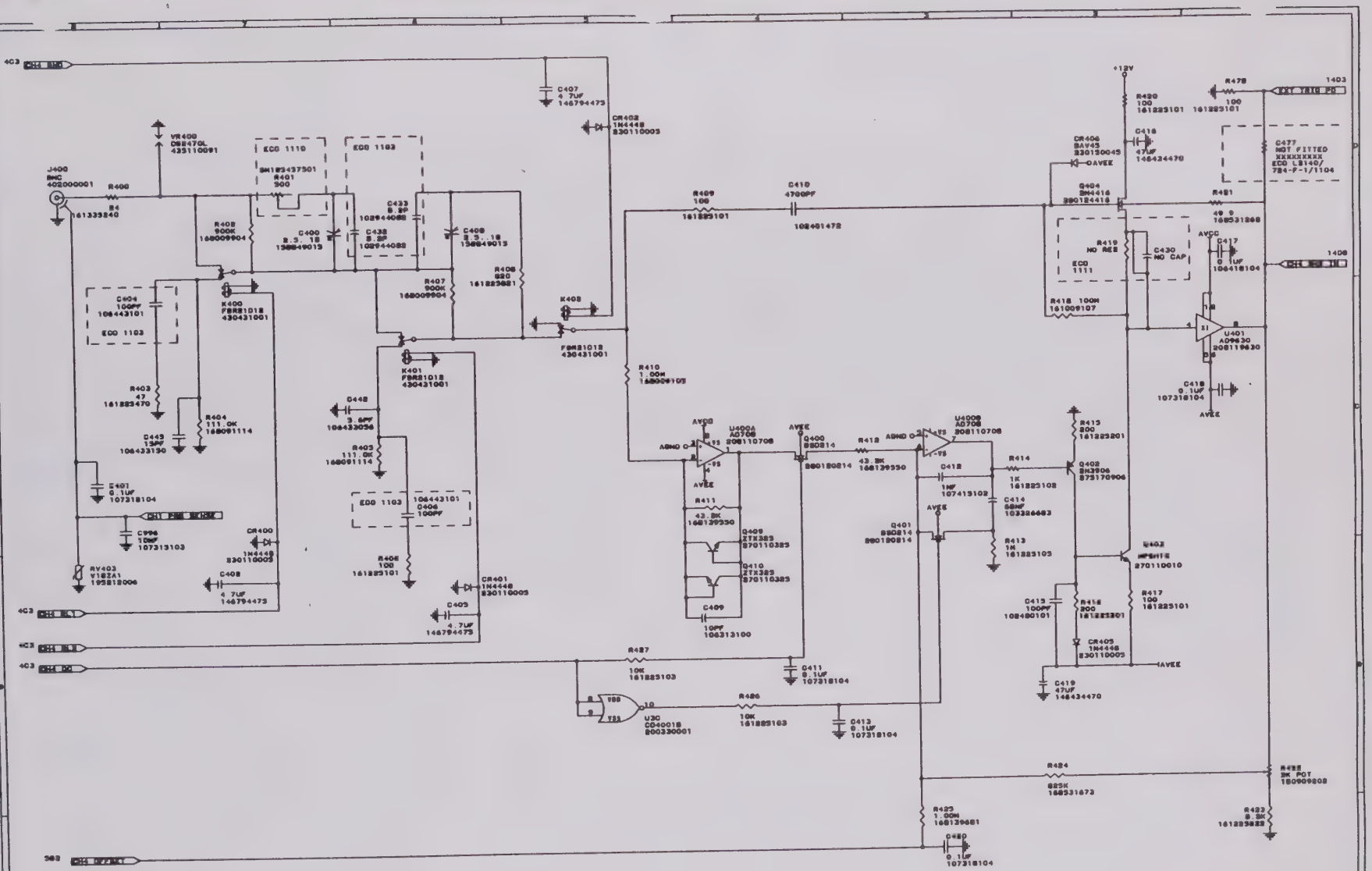
Title: CHANNEL 3 SECOND STAGE

Size	Document Number	REV
C	SC1F03_2.SCH	B

Date: October 8, 1993 Sheet 18 of 35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ECO 1103
ECO 1111
NO REE
NO CAP
NOT FITTED
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ECO LB140/
784-F-1/1104
+12V
-5VEE
AVCC
AVEE
AGND
U401
AD9630
208119630
U400A
AD708
208110708
U400B
AD708
208110708
U3C
CD40018
800330001
Q400
BS0814
800180814
Q401
BS0814
800180814
Q402
BN3906
870170906
Q403
MPSH10
870110010
Q404
BN4416
800124416
Q409
ZTX383
870110383
Q410
ZTX383
870110383
CR400
1N4448
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CR401
1N4448
830110003
CR402
1N4448
830110003
CR403
1N4448
830110003
CR406
BAV45
830130045
VR400
CM3470L
435110091
RV403
V18ZA1
195812006
J400
BNC
402000001
R400
161335840
R401
900
R402
900K
168009904
R403
47
161225470
R404
111.0K
168091114
R405
100
161225101
R406
820
161225821
R407
900K
168009904
R408
900K
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R409
100
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R410
1.00K
168009103
R411
43.2K
168129350
R412
43.2K
168129350
R413
200
161225201
R414
1K
161225102
R415
200
161225201
R416
3K POT
180909808
R417
100
161225101
R418
100K
161009107
R419
R420
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161225101
R421
49.9
168531868
R422
8.9K
161225822
R423
1.00K
168129681
R424
825K
168531673
R427
10K
161225103
R428
10K
161225103
R429
R478
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161225101
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C401
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107318104
C402
3.6PF
106432036
C403
4.7UF
146794473
C404
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106443101
C405
100PF
106443101
C406
100PF
C407
4.7UF
146794473
C408
4.7UF
146794473
C409
10PF
106313100
C410
470PF
102401472
C411
0.1UF
107318104
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1NF
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C414
68NF
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100PF
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47UF
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C448
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K400
FSR81018
430431001
K401
FSR81018
430431001
K408
FSR81018
430431001
1403
1408
4C3
3B3
ECO: 784-F-1/1111
LeCroy Ltd.
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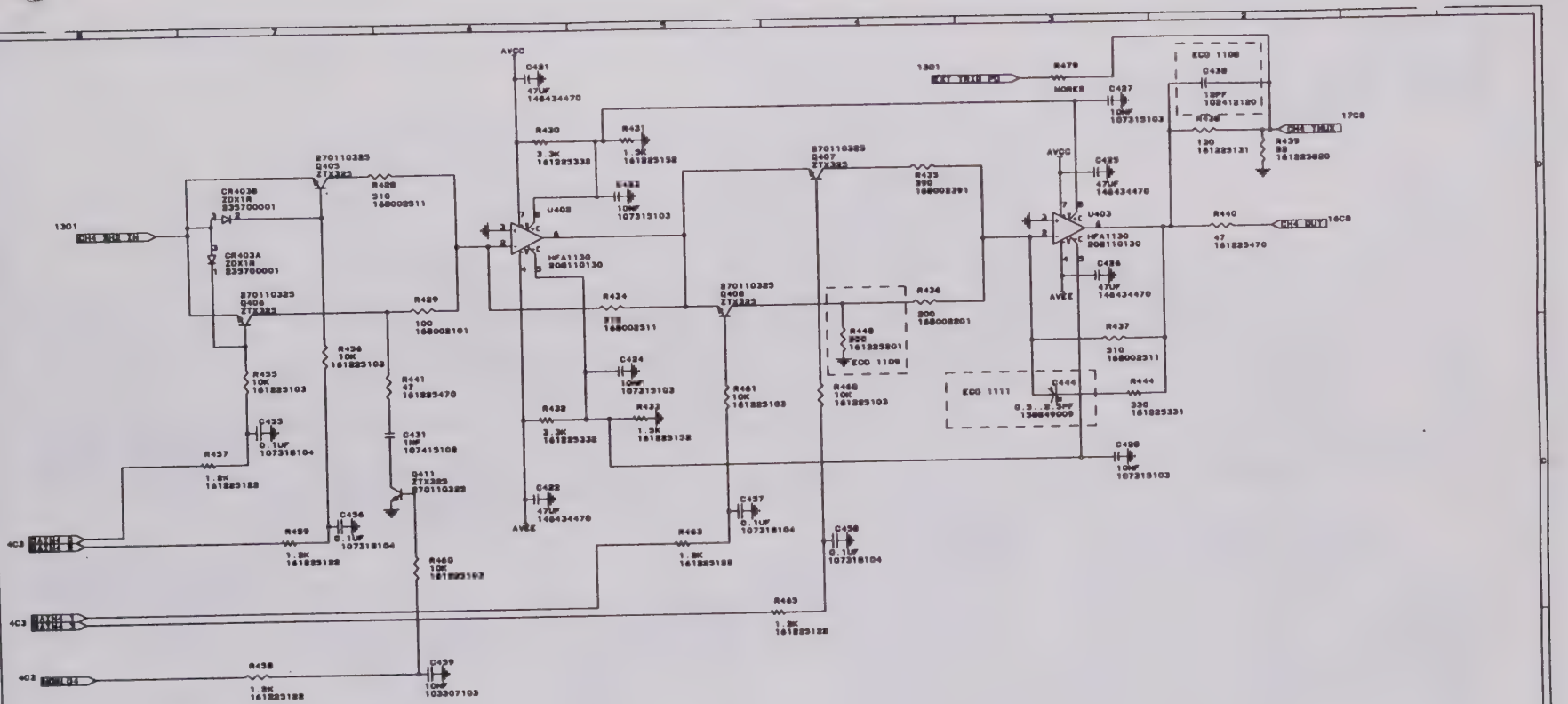
Title
CHANNEL 4 INPUT (HI-Z) STAGE
Size
C
Document Number
SDTF04_1 SCH
REV
B
Date: October 7, 1993 Sheet 13 of 33



MODLD	GAIN_0	GAIN_1	GAIN_2	GAIN_3	SELECTION	RANGE
	1	0	0	1	8	100mV 1V 10V
	1	0	1	0	9	200mV 500mV 5V
	1	0	1	1	10	200mV 800mV 8V
	0	1	0	0	11	10V
	0	1	0	1	12	5V
	0	1	1	0	13	2V
	0	1	1	1	14	DESELECTED

ECO: 784-F-1/1111

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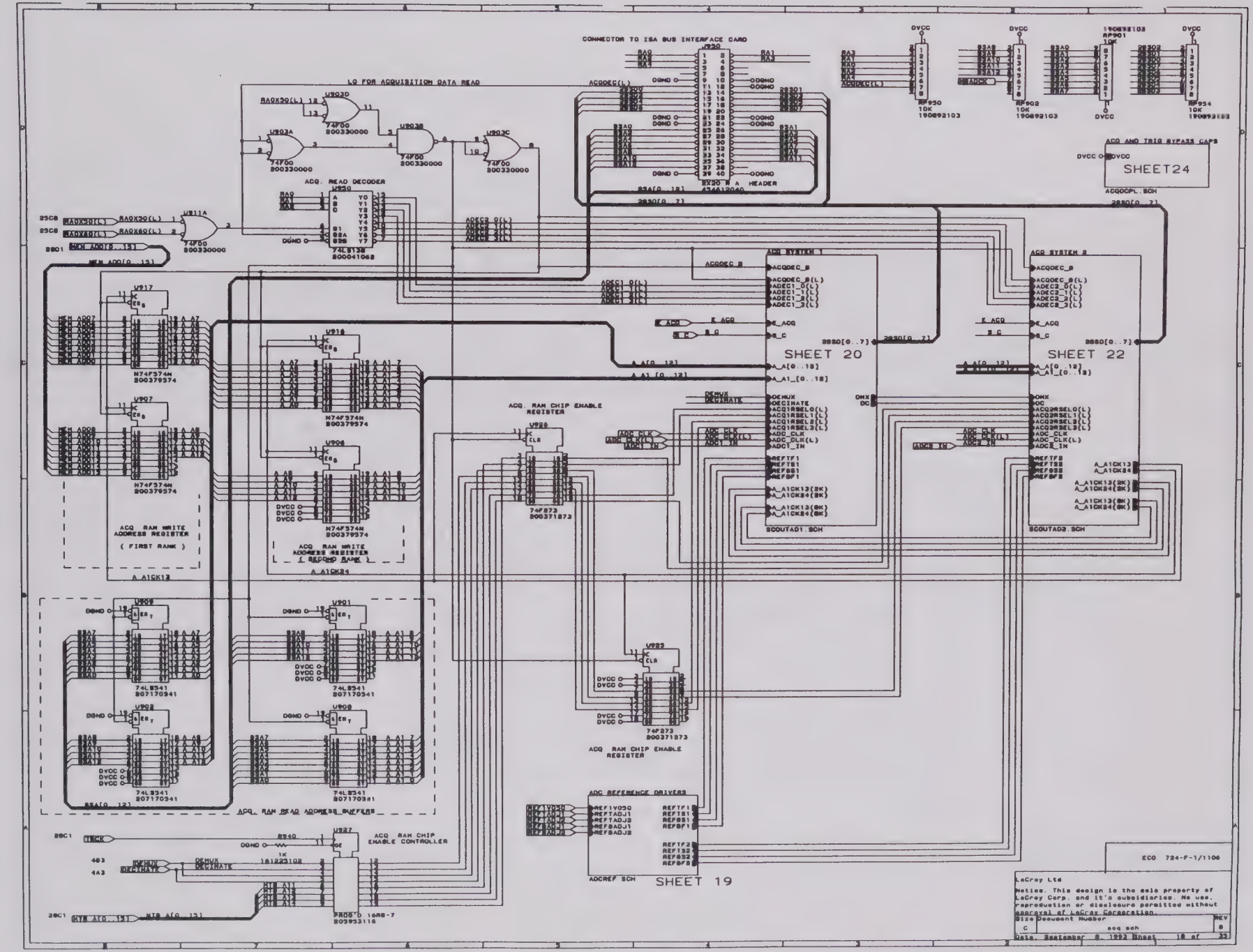
Title: CHANNEL 4 SECOND STAGE

Size: C | Document Number: SCTF04_2 SCH | REV: B

Date: Dataac 8, 1993 Sheet 14 of 35


CONNECTOR TO ISA BUS INTERFACE CARD
LO FOR ACQUISITION DATA READ
ACQ. READ DECODER
ACQ RAM WRITE ADDRESS REGISTER (FIRST RANK)
ACQ RAM WRITE ADDRESS REGISTER (SECOND RANK)
ACQ. RAM READ ADDRESS BUFFERS
ACQ RAM CHIP ENABLE CONTROLLER
ACQ RAM CHIP ENABLE REGISTER
ACQ REFERENCE DRIVERS
ACQ SYSTEM 1
ACQ SYSTEM 2
SHEET 20
SHEET 22
SHEET 19
SHEET24
SCOUTAD1.SCH
SCOUTAD2.SCH
ADCREF.SCH
ACQDCPL.SCH
ECO 734-F-1/1106
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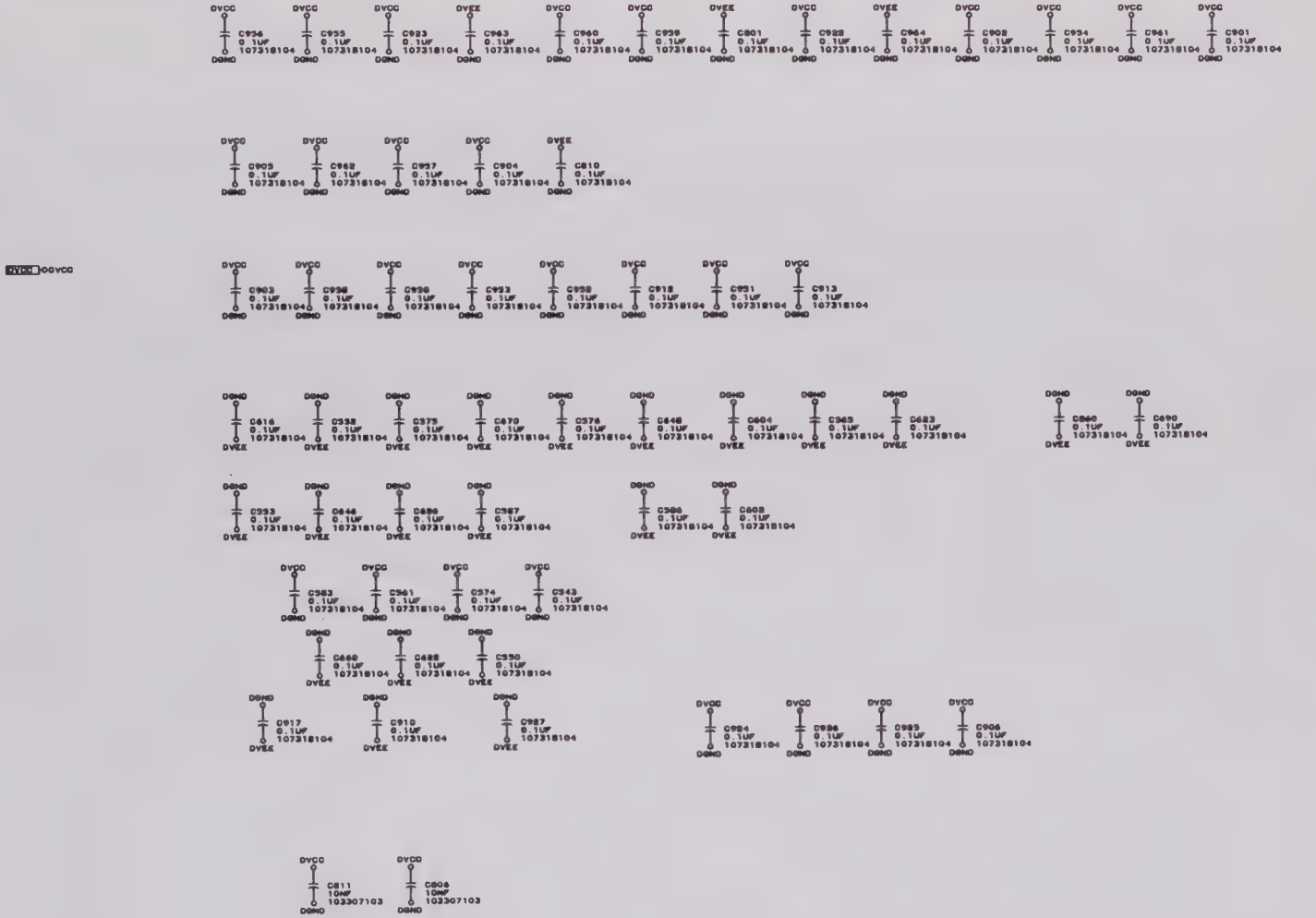
Size Document Number REV
C acq.sch B
Date: September 8, 1993 Sheet 18 of 33



ECO: 784-F-1/1106

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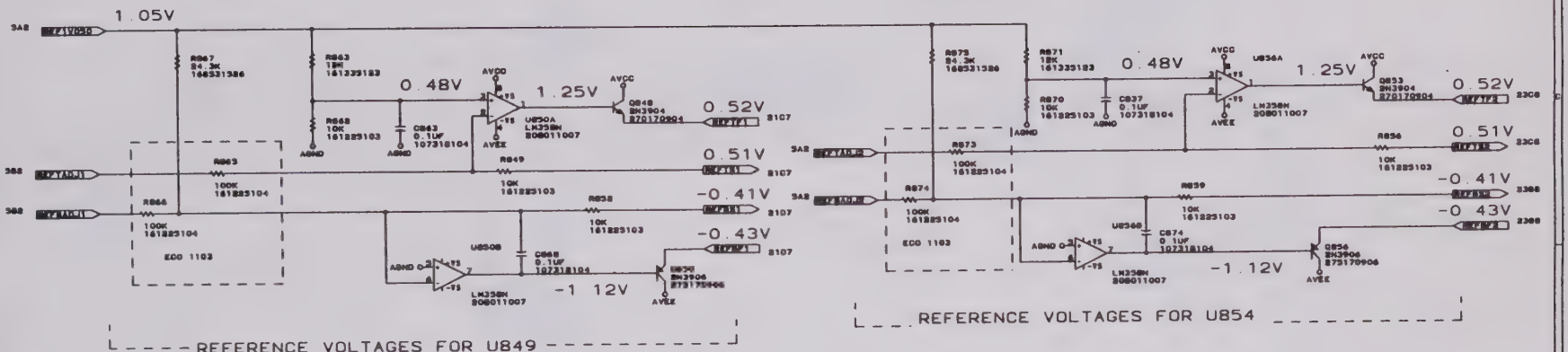
Title: ACQUISITION AND TRIGGER BYPASS CAPACITORS

Size: C | Document Number: ACQDCPL.SCH | REV: B

Date: September 8, 1993 | Sheet 24 of 35

VOLTAGES SHOWN ARE NOT PRECISE.
THEY WILL CHANGE AT DIFFERENT VOLTS/DIV SETTINGS.
THEY WILL BE DIFFERENT BETWEEN INSTRUMENTS.



ECO. 784-F-1/1106

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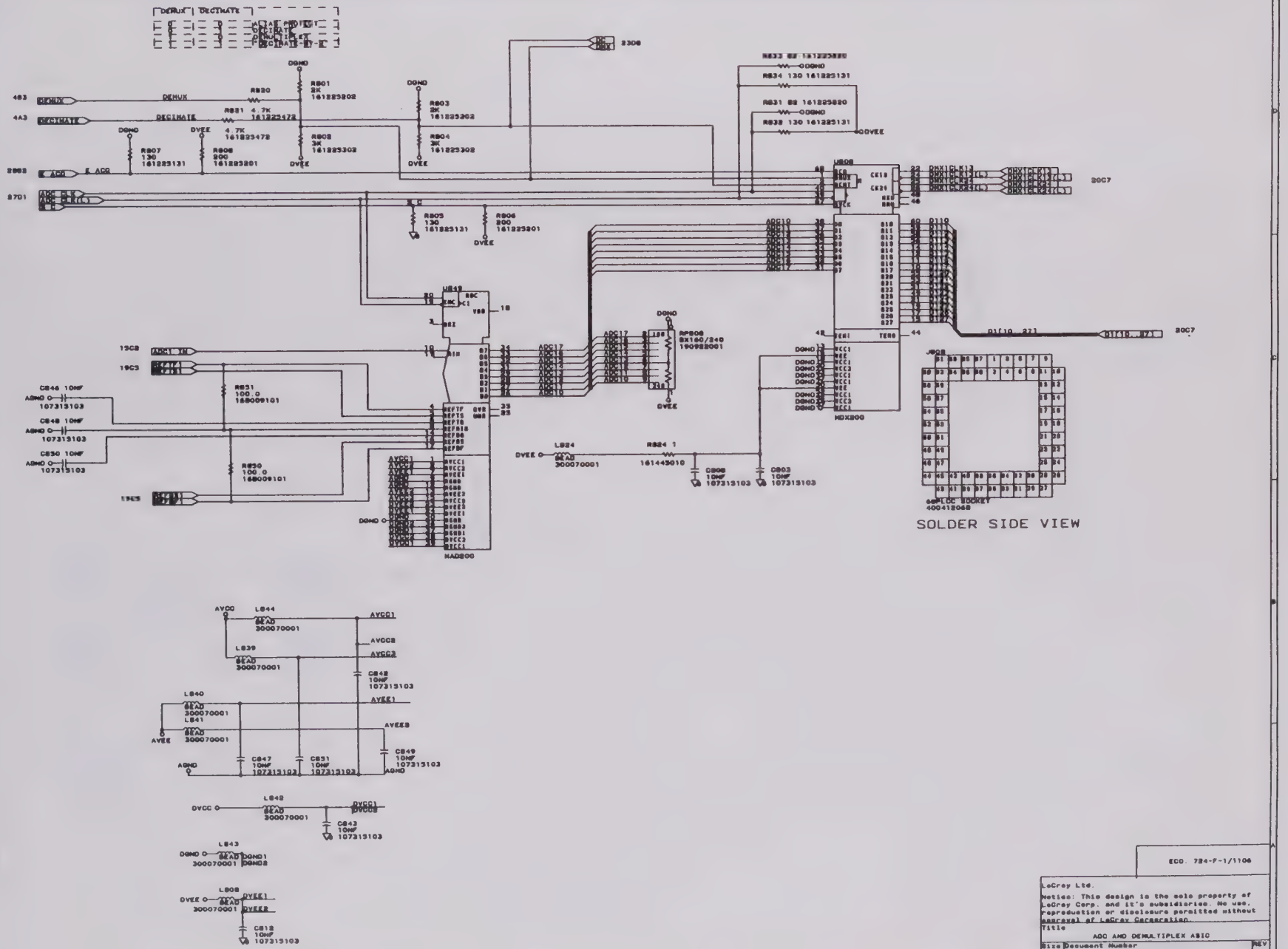
Title: ADC REFERENCE ADJUSTORS

Size: C | Document Number: adcref.sch | REV: B

Date: September 8, 1993 | Sheet 19 of 33


SOLDER SIDE VIEW
ECO. 724-F-1/1106
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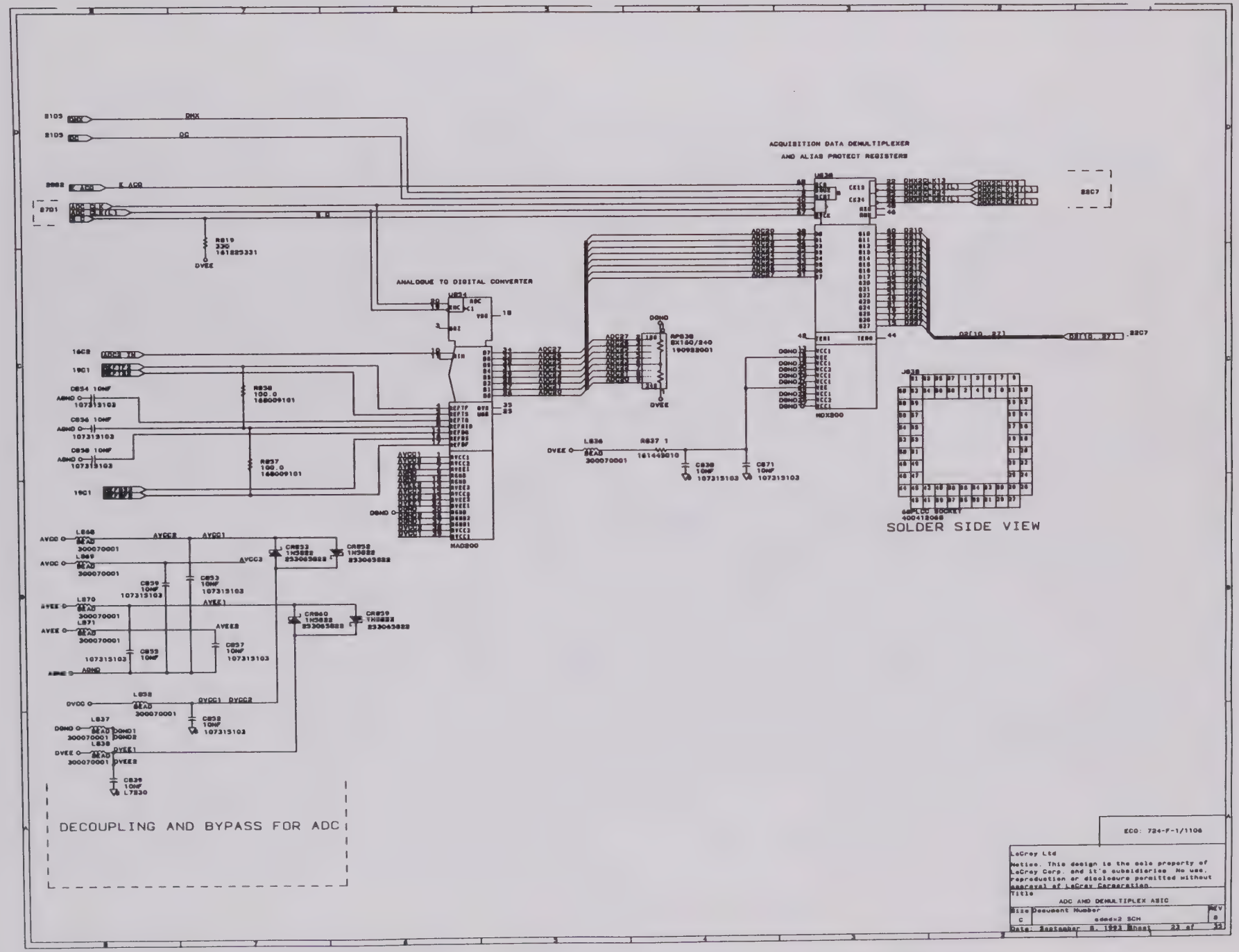
Title
ADC AND DEMULTIPLEX ASIC
Size C
Document Number
adadx1 SCH
REV B
Date: September 8, 1993 Sheet 21 of 35


ACQUISITION DATA DEMULTIPLEXER
AND ALIAS PROTECT REGISTERS
ANALOGUE TO DIGITAL CONVERTER
MAD800
MDX300
SOLDER SIDE VIEW
DECOUPLING AND BYPASS FOR ADC
ECO: 724-F-1/1106
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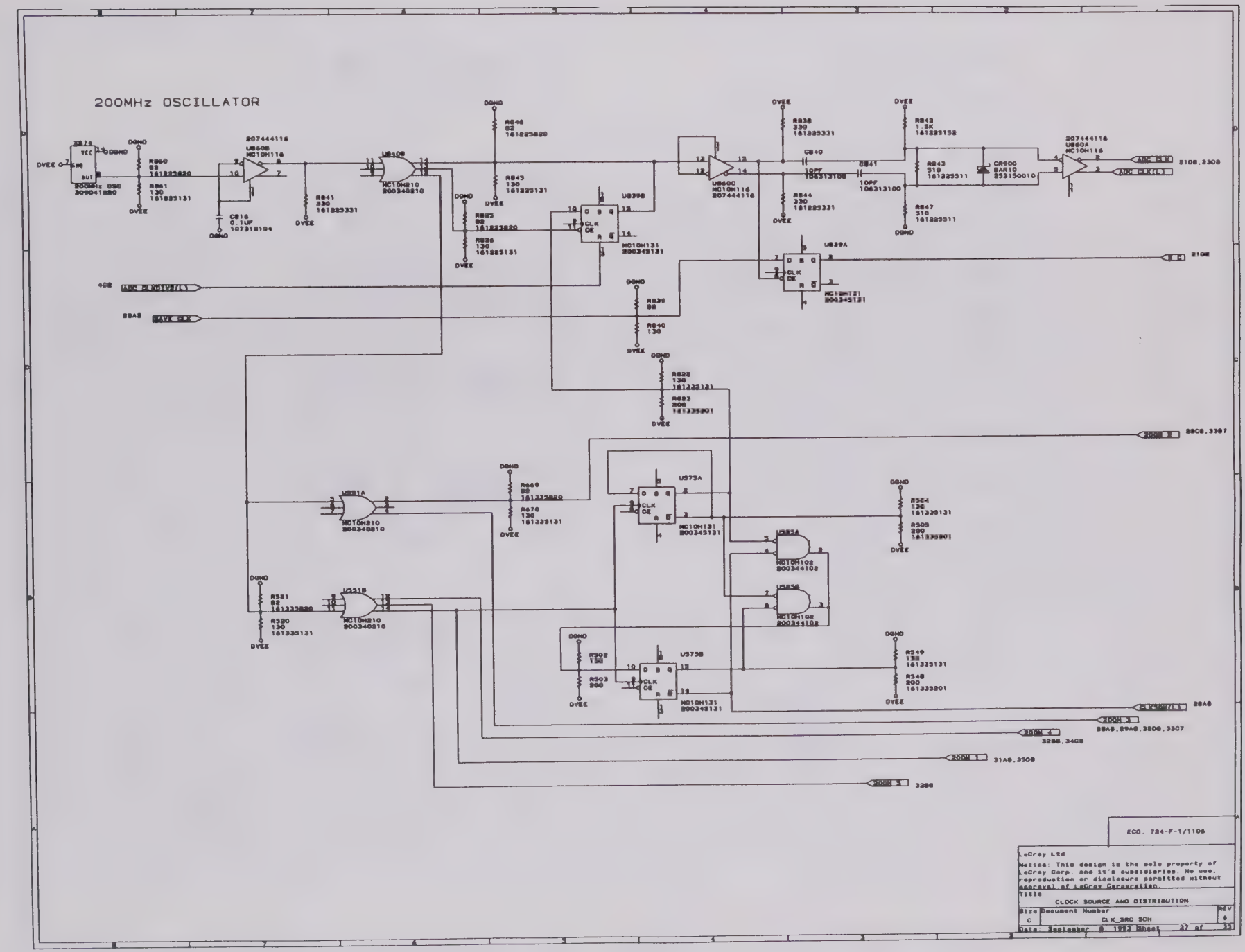
Title
ADC AND DEMULTIPLEX ASIC
Size
Document Number
Rev
C
adac+2 SCM
B
Date: September 8, 1993 Sheet 23 of 33


200MHz OSCILLATOR
DGND
DVEE
MC10H116
MC10H210
MC10H131
MC10H102
CLK
OE
ECO. 734-F-1/1106
LeCroy Ltd
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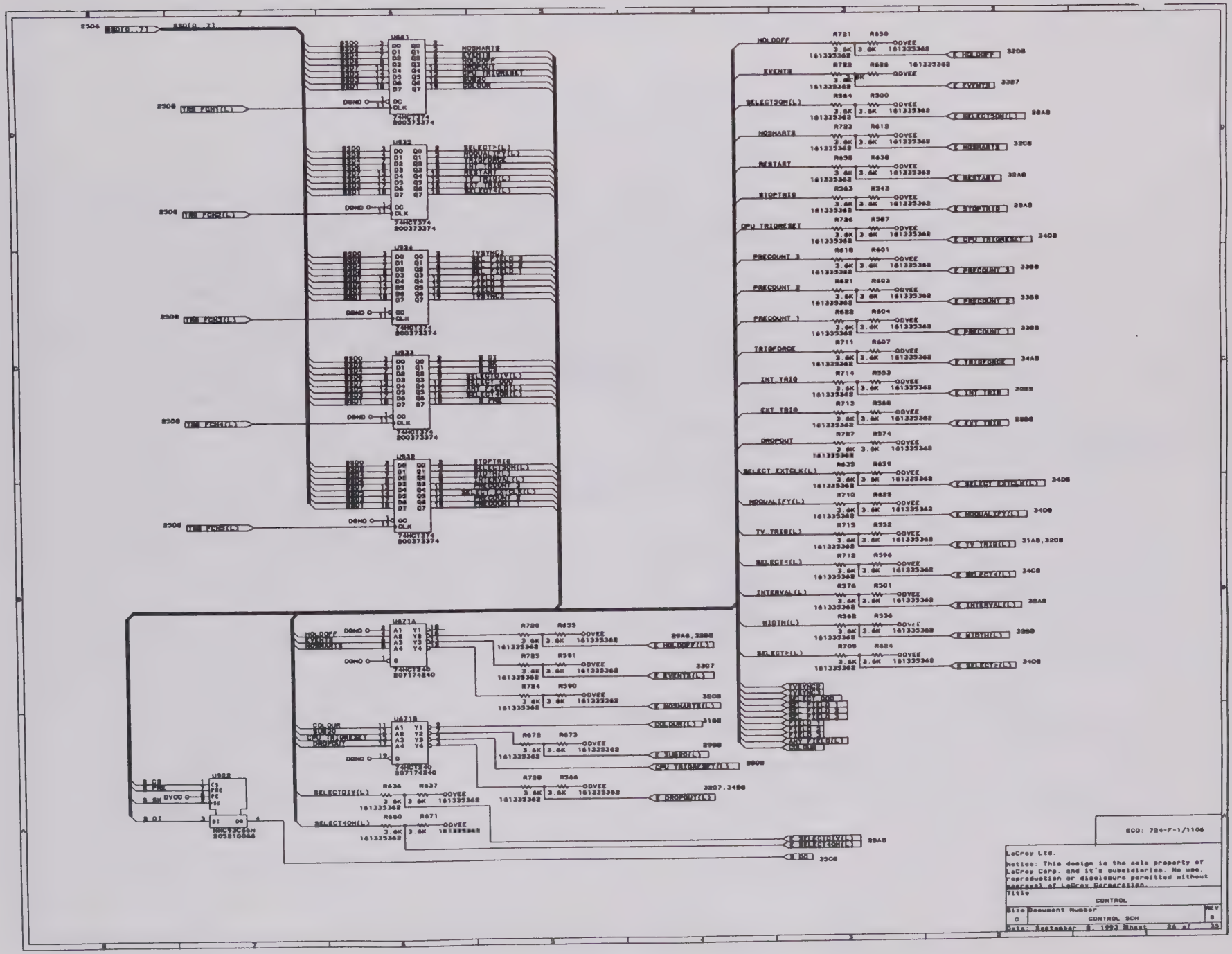
Title
CLOCK SOURCE AND DISTRIBUTION
Size
C
Document Number
CLK_SRC SCH
REV
B
Date: September 8, 1993
Sheet 27 of 33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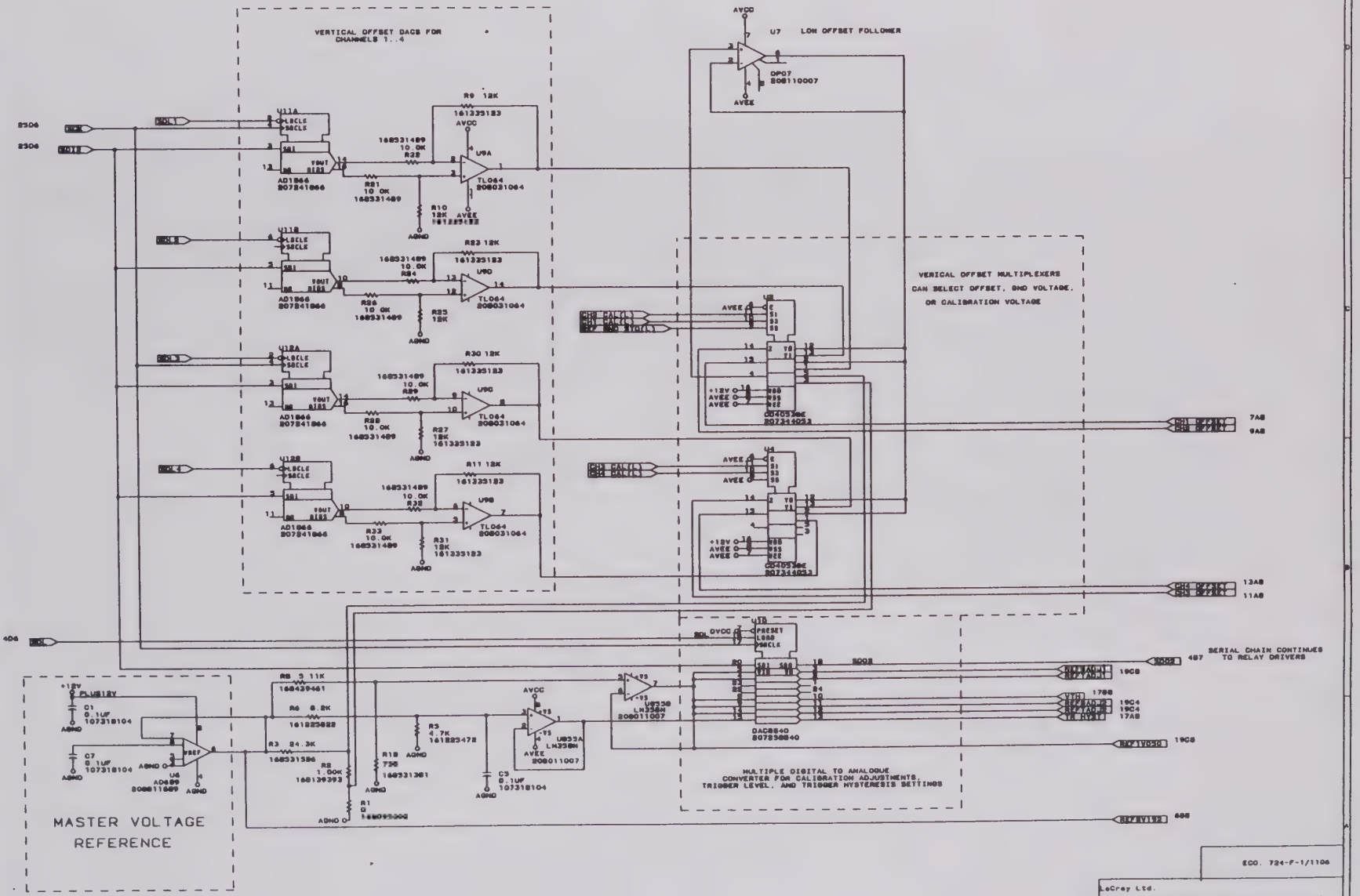
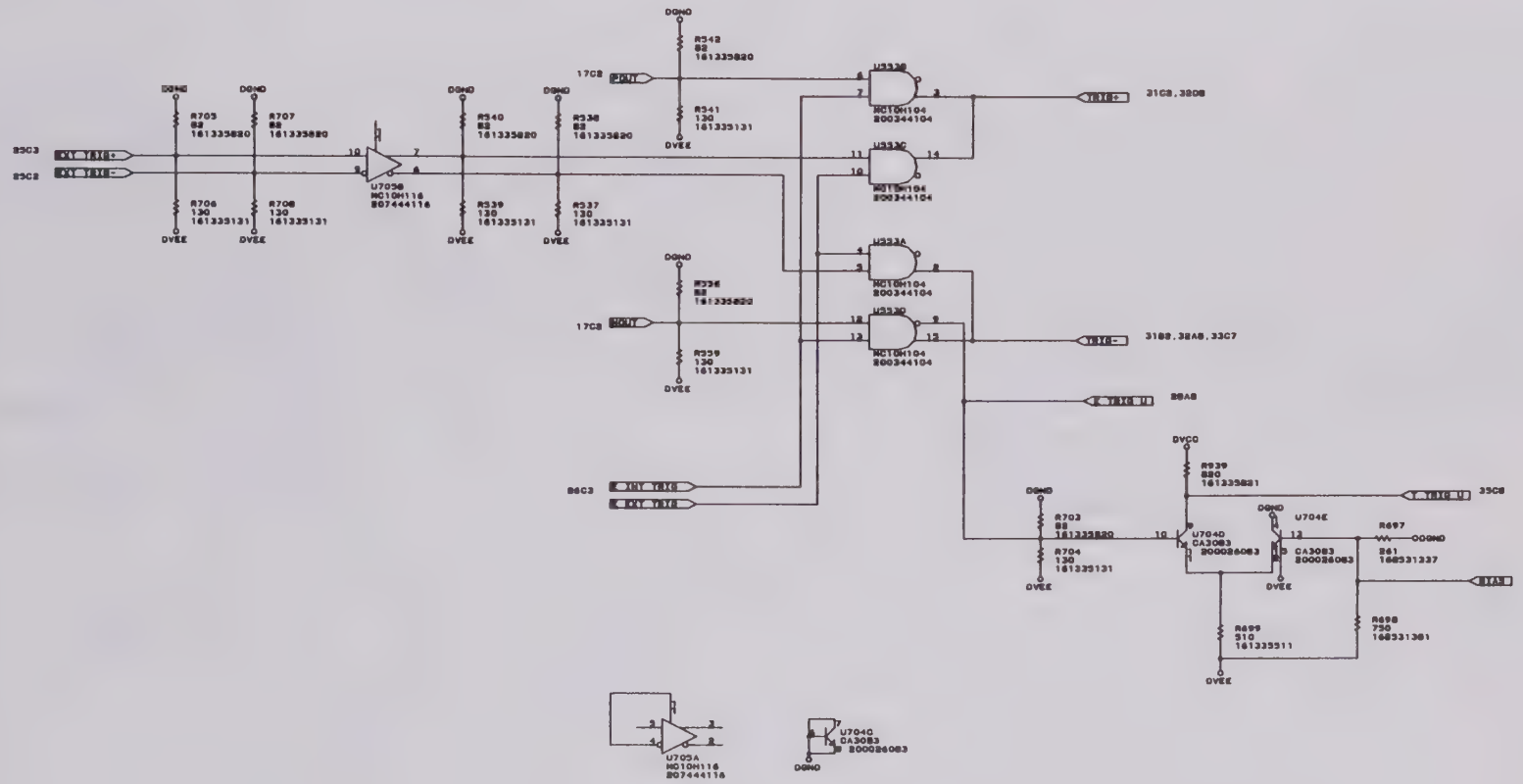
U832
U833
U834
U835
U838
74HCT374
800373374
U671A
U671B
74HCT540
807174840
U822
HMC93C66M
805810066
R720
R635
R721
R630
R722
R636
R723
R612
R638
R639
R726
R587
R618
R601
R621
R603
R622
R604
R711
R607
R714
R553
R712
R560
R727
R574
R635
R639
R710
R625
R713
R558
R718
R596
R576
R501
R562
R536
R709
R624
R784
R390
R785
R391
R672
R673
R728
R564
R636
R637
R660
R671
HOLDOFF
EVENTR
SELECT20M(L)
NOSMARTR
RESTART
STOPTRIG
CPU TRIGRESET
PRECOUNT 3
PRECOUNT 2
PRECOUNT 1
TRIGFORCE
INT TRIG
EXT TRIG
DROPOUT
SELECT EXTCLK(L)
MODQUALIFY(L)
TV TRIG(L)
SELECT<(L)
INTERVAL(L)
WIDTH(L)
SELECT>(L)
SELECTDIV(L)
SELECT40M(L)
3208
3207
3208
3208
3208


VERTICAL OFFSET DACS FOR CHANNELS 1..4
U7 LOW OFFSET FOLLOWER
VERICAL OFFSET MULTIPLEXERS CAN SELECT OFFSET, GND VOLTAGE, OR CALIBRATION VOLTAGE
MULTIPLE DIGITAL TO ANALOGUE CONVERTER FOR CALIBRATION ADJUSTMENTS, TRIGGER LEVEL, AND TRIGGER HYSTERESIS SETTINGS
MASTER VOLTAGE REFERENCE
SERIAL CHAIN CONTINUES TO RELAY DRIVERS
DACREF SCH
LeCroy Ltd.



ECO 724-F-1/1104

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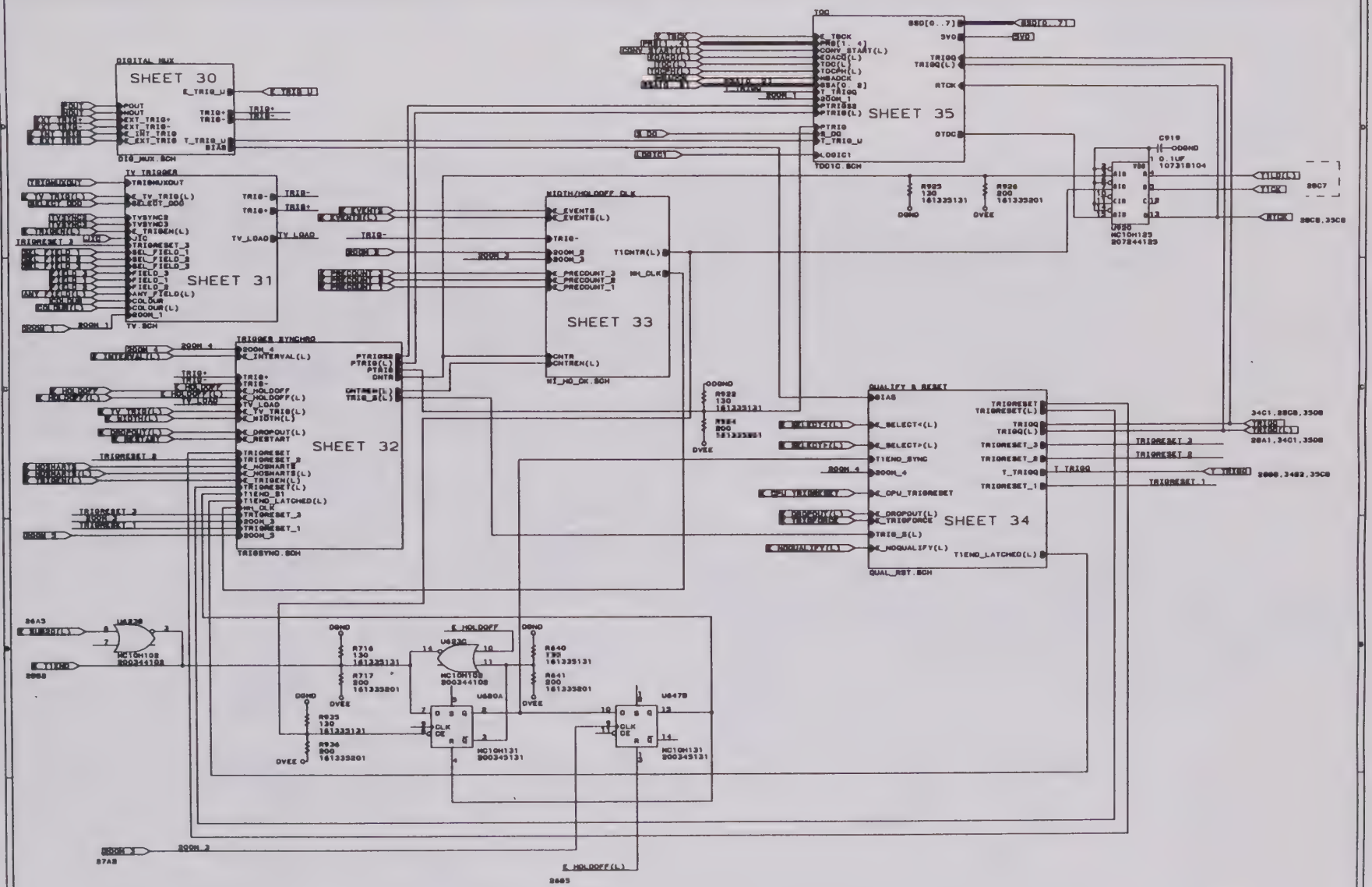
Title

DIGITAL MUX

Size	Document Number	REV
C	DIG_MUX SCH	B

Date: September 6, 1993 Sheet 30 of 35


DIGITAL MUX
SHEET 30
DIG_MUX.SCH
TV TRIGGER
SHEET 31
TV.SCH
TRIGGER SYNCHRO
SHEET 32
TRIGSYNC.SCH
HIGTH/HOLDOFF CLK
SHEET 33
HI_HO_CK.SCH
QUALIFY & RESET
SHEET 34
QUAL_RST.SCH
TDC
SHEET 35
TDC1C.SCH
ECO: 724-F-1/1106
LeCroy Ltd
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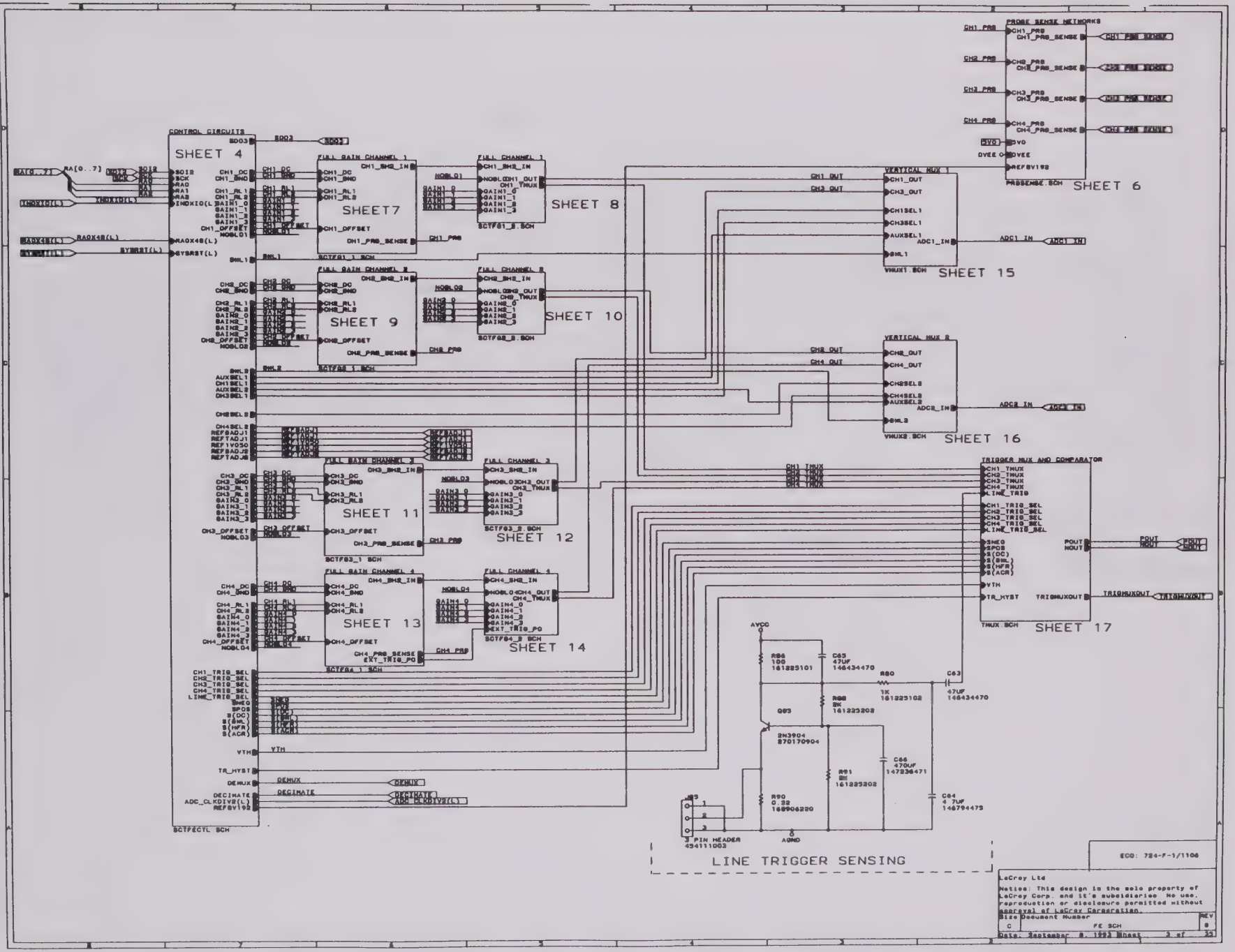
Title
DIGITAL TRIGGER
Size
C
Document Number
DIG_TRIG.SCH
REV
B
Date: September 8, 1993 Sheet 33 of 33


PROBE SENSE NETWORKS
PROBESENSE.SCH
SHEET 6
CONTROL CIRCUITS
SHEET 4
SCTFECTL.SCH
SHEET7
SCTF01_1.SCH
SHEET 8
SCTF01_B.SCH
SHEET 9
SCTF02_1.SCH
SHEET 10
SCTF02_B.SCH
SHEET 11
SCTF03_1.SCH
SHEET 12
SCTF03_B.SCH
SHEET 13
SCTF04_1.SCH
SHEET 14
SCTF04_B.SCH
VERTICAL MUX
VMUX1.SCH
SHEET 15
VERTICAL MUX 2
VMUX2.SCH
SHEET 16
TRIGGER MUX AND COMPARATOR
TMUX.SCH
SHEET 17
LINE TRIGGER SENSING
ECO: 784-F-1/1106
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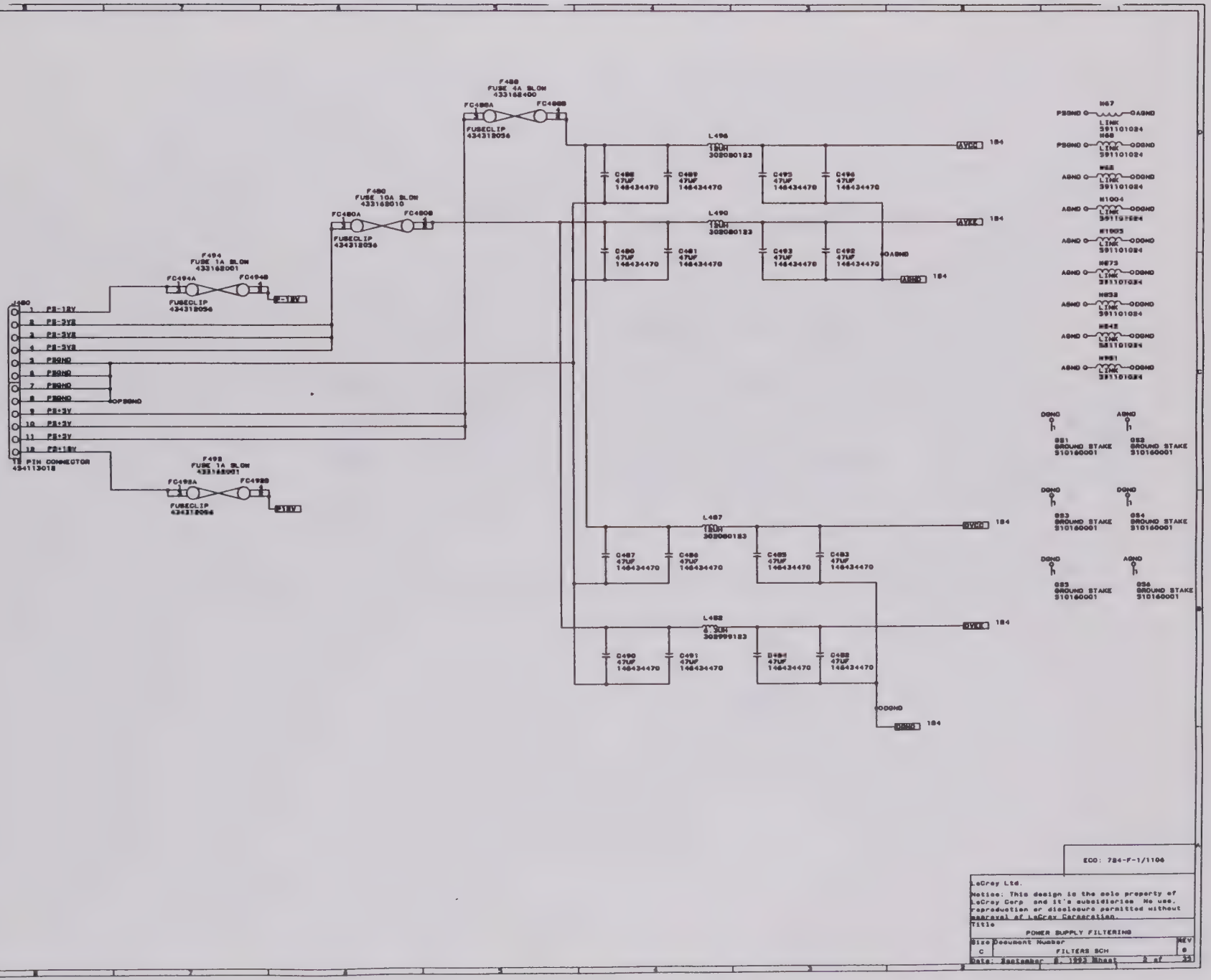
Size Document Number REV
C FE SCH B
Date: Wednesday, 8, 1993 Sheet 3 of 33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FUSE 4A SLOW
433168400
FC488A
FC488B
FUSECLIP
434318036
F489
FUSE 10A SLOW
433168010
FC489A
FC489B
FUSECLIP
434318036
F494
FUSE 1A SLOW
433168001
FC494A
FC494B
FUSECLIP
434318056
+31V
J490
1 PS-12V
2 PS-5VS
3 PS-5VS
4 PS-5VS
5 PSGND
6 PSGND
7 PSGND
8 PSGND
9 PS+5V
10 PS+5V
11 PS+5V
12 PS+12V
12 PIN CONNECTOR
434113018
OPSGND
F498
FUSE 1A SLOW
433168001
FC498A
FC498B
FUSECLIP
434318056
+12V
L496
180uH
302080183
L490
180uH
302080183
L497
180uH
302080183
L498
180uH
302080183
C488 47UF 146434470
C489 47UF 146434470
C493 47UF 146434470
C496 47UF 146434470
C480 47UF 146434470
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C493 47UF 146434470
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C483 47UF 146434470
C490 47UF 146434470
C491 47UF 146434470
C484 47UF 146434470
C482 47UF 146434470
AVCC
184
AVEE
184
AGND
184
DVCC
184
DVEE
184
DGND
184
H67
PSGND
AGND
LINK
391101024
H68
PSGND
DGND
H69
AGND
DGND
H1004
AGND
DGND
H1005
AGND
DGND
H673
AGND
DGND
H633
AGND
DGND
H645
AGND
DGND
H951
AGND
DGND
GS1
GROUND STAKE
310160001
GS2
GROUND STAKE
310160001
GS3
GROUND STAKE
310160001
GS4
GROUND STAKE
310160001
GS5
GROUND STAKE
310160001
GS6
GROUND STAKE
310160001
ECO: 784-F-1/1106
LeCroy Ltd.
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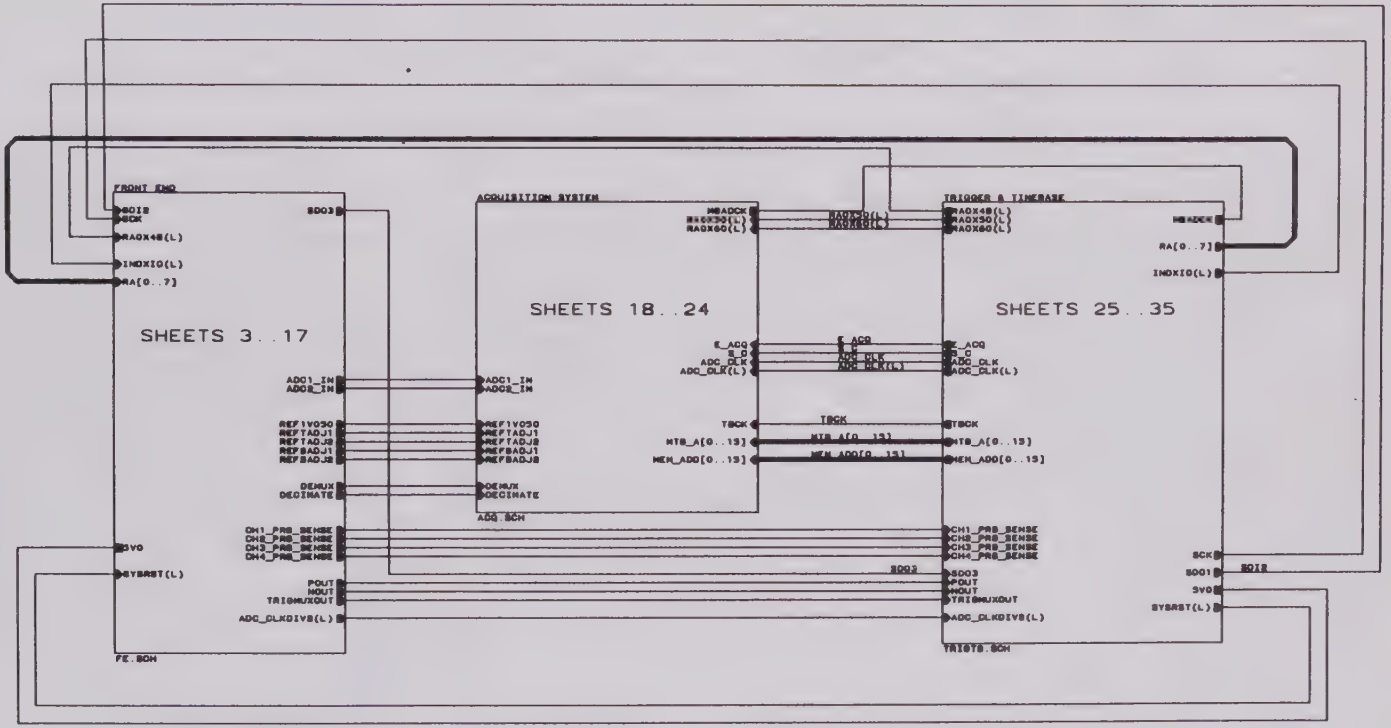
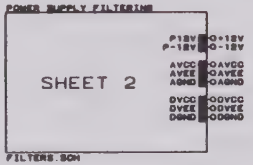
Title
POWER SUPPLY FILTERING
Size C
Document Number
FILTERS SCH
REV 0
Date: September 8, 1993 Sheet 5 of 33





ECO. 784-F-1/1106

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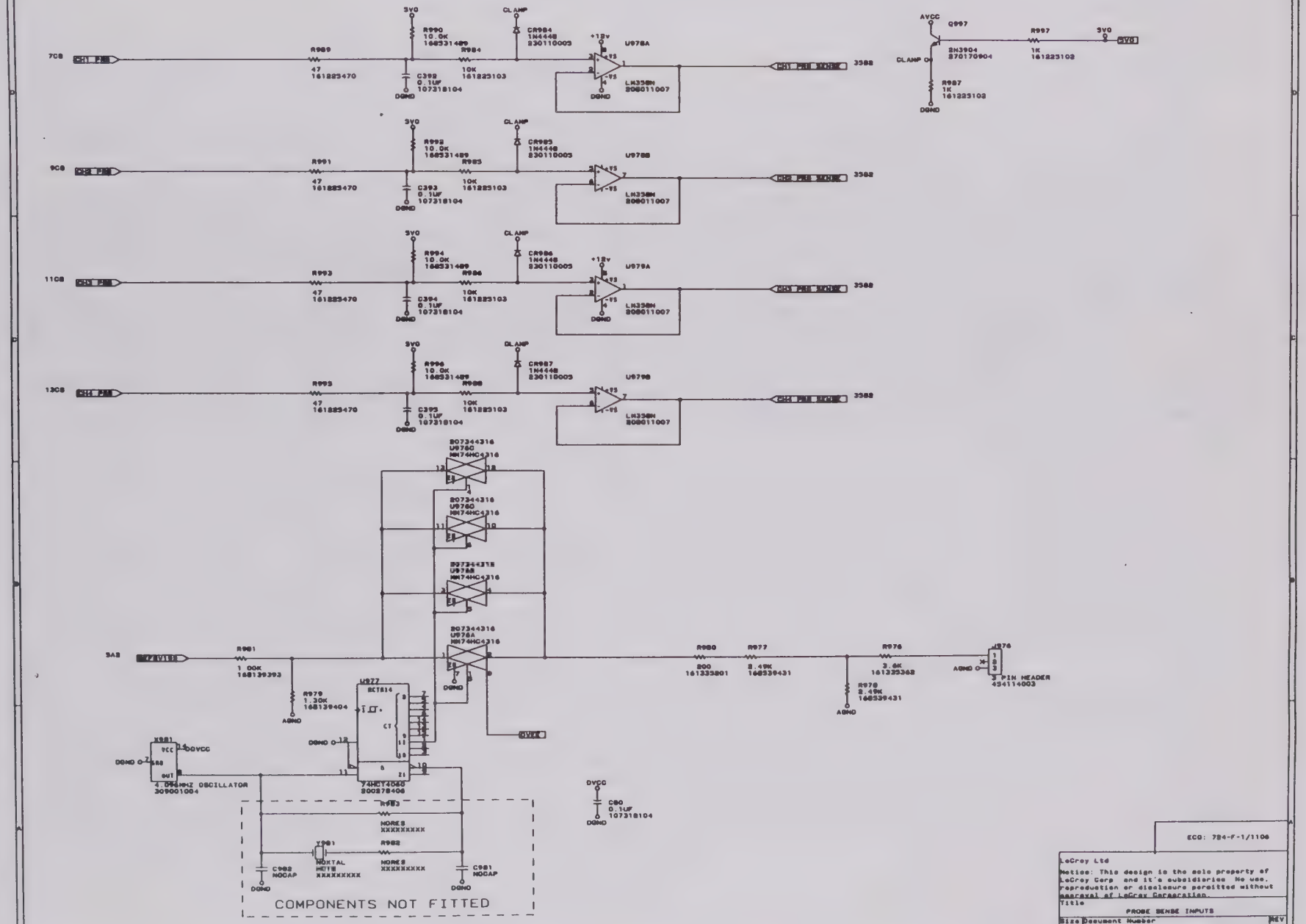
Title

LS140 ACQUISITION BOARD 784-F-1

Size	Document Number	REV
C	MAIN SCH	B

Date: September 8, 1993 Sheet 1 of 35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R989
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DGND
+12V
U978A
LM358N
806011007
3388
AVCC
Q997
2N3904
870170904
R997
1K
161825102
R987
1K
161825102
R991
R993
R994
R995
R996
R998
R992
R985
R986
R988
C393
C394
C395
U978B
U979A
U979B
BQ7344316
U976D
MM74HC4316
U976C
U976B
U976A
R981
1.00K
168139393
R979
1.30K
168139404
U977
BCT814
74HCT4040
800278406
X981
4.096MHZ OSCILLATOR
309001004
DVCC
R980
200
161339801
R977
8.49K
168339431
R976
3.6K
161339368
R978
8.49K
168339431
J976
3 PIN HEADER
434114003
AGND
DGND
C980
0.1UF
107318104
R983
NORES
XXXXXXXXX
R982
NORES
XXXXXXXXX
C982
NOCAP
C981
NOCAP
COMPONENTS NOT FITTED
ECO: 784-F-1/1106
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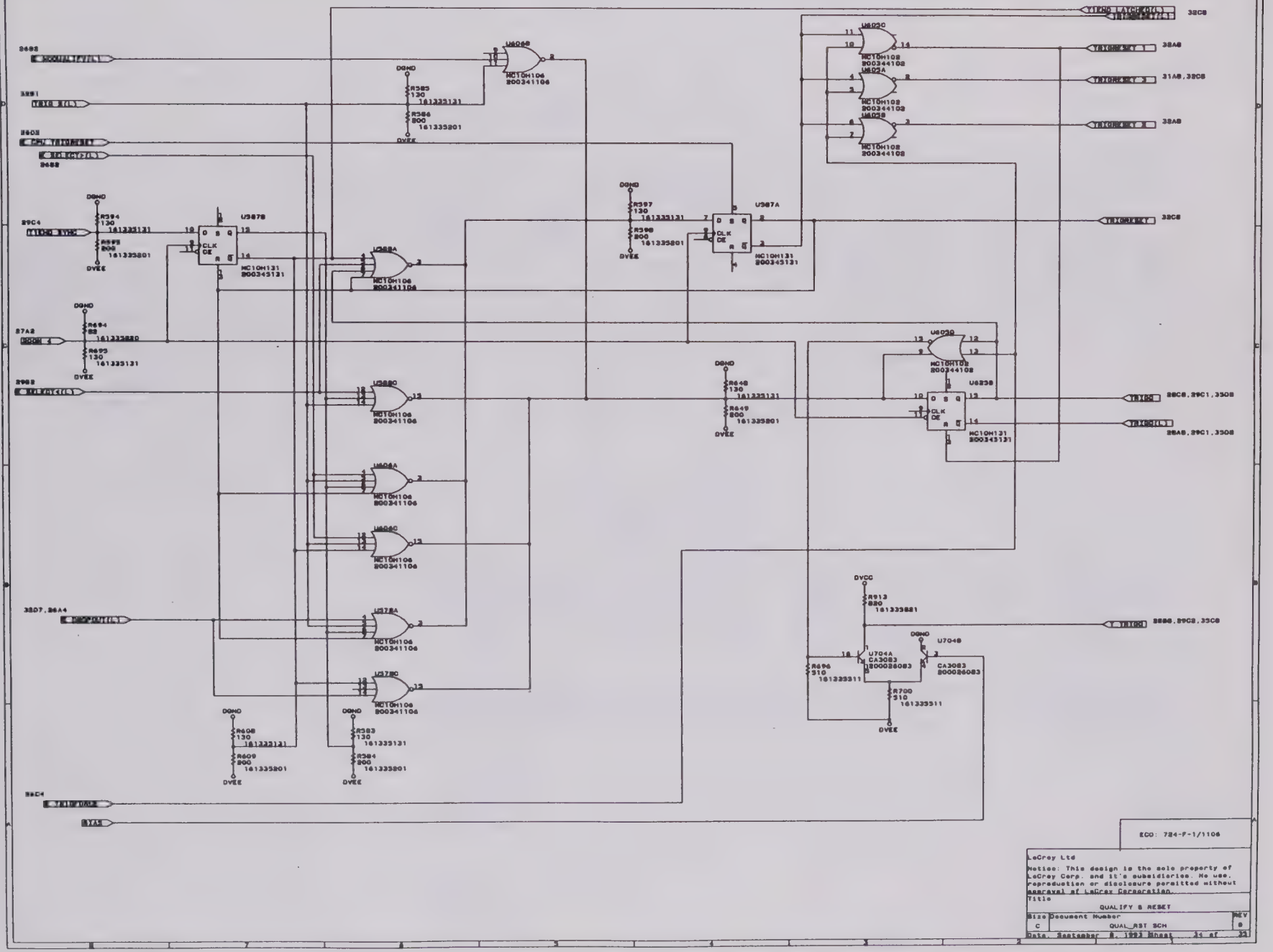
Title
PROBE SENSE INPUTS
Size
C
Document Number
REV
B
Date: September 8, 1993 Sheet 6 of 33



ECO: 724-F-1/1106

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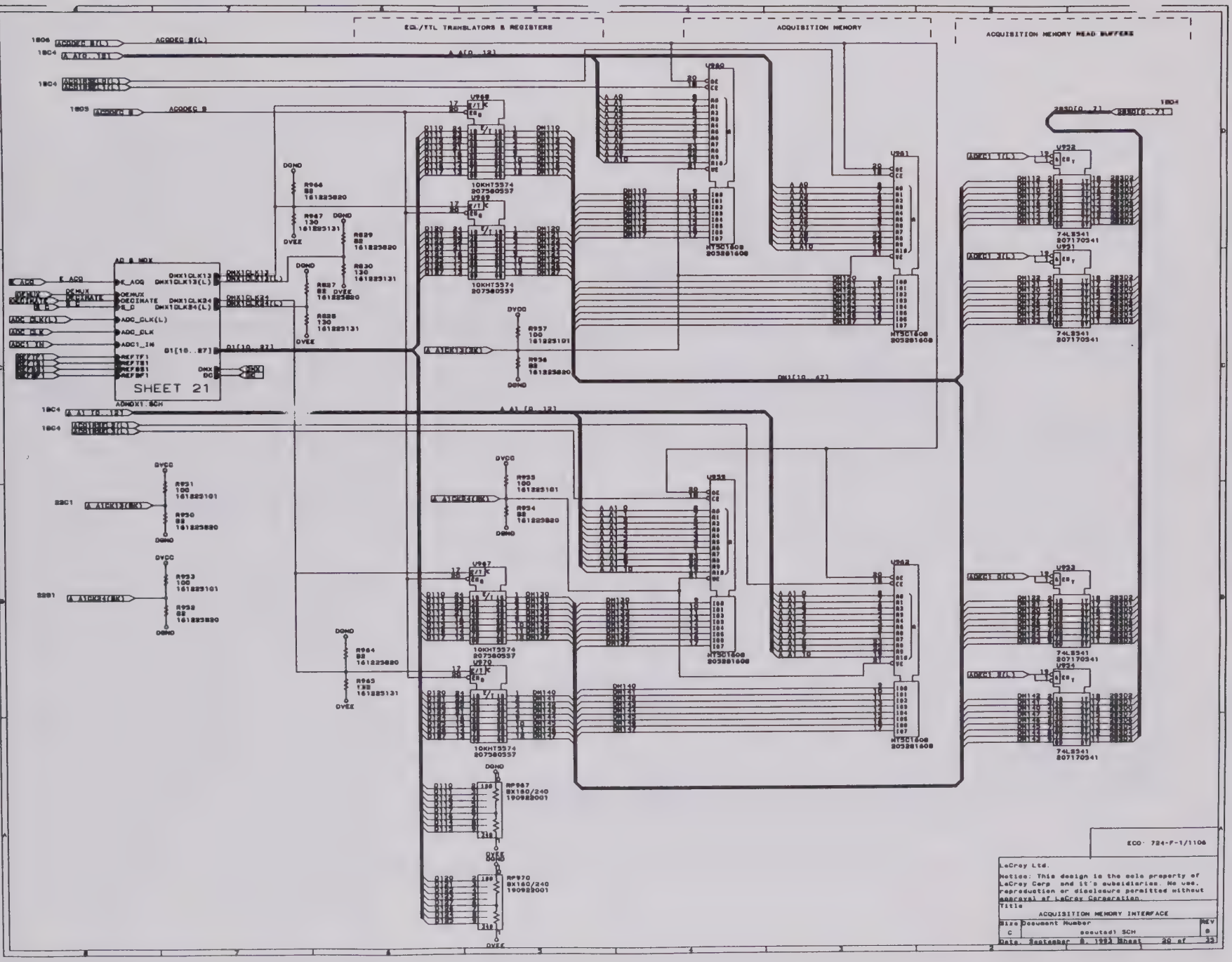
Title: QUALIFY & RESET

Size: C | Document Number: QUAL_RST SCH | REV: B

Date: September 8, 1993 | Sheet 34 of 35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ECO: 724-F-1/1106
LeCroy Ltd.
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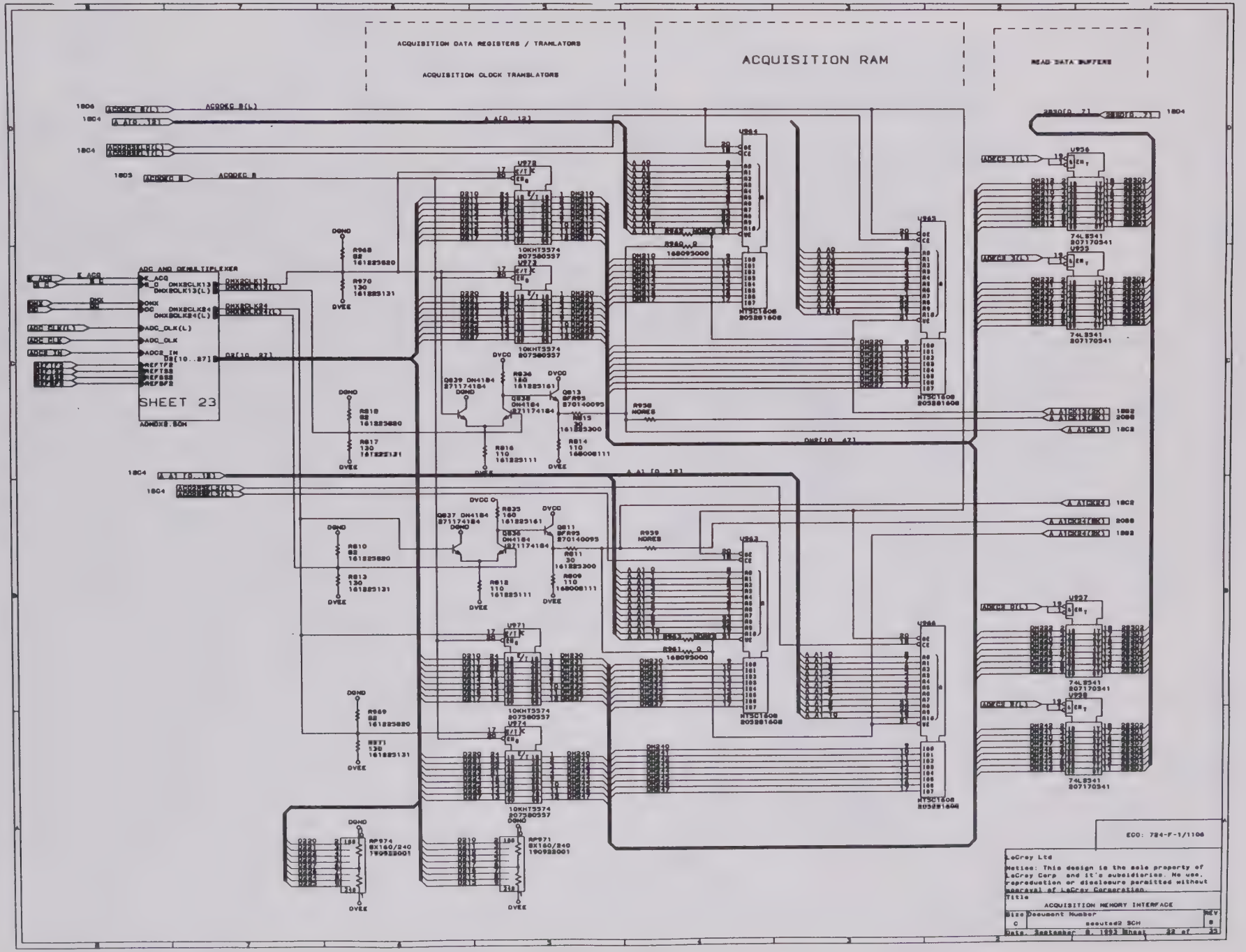
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R813
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R969
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R971
130
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R939
NOMEB
R938
NOMEB
RP974
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ECO: 784-F-1/1106
LeCroy Ltd
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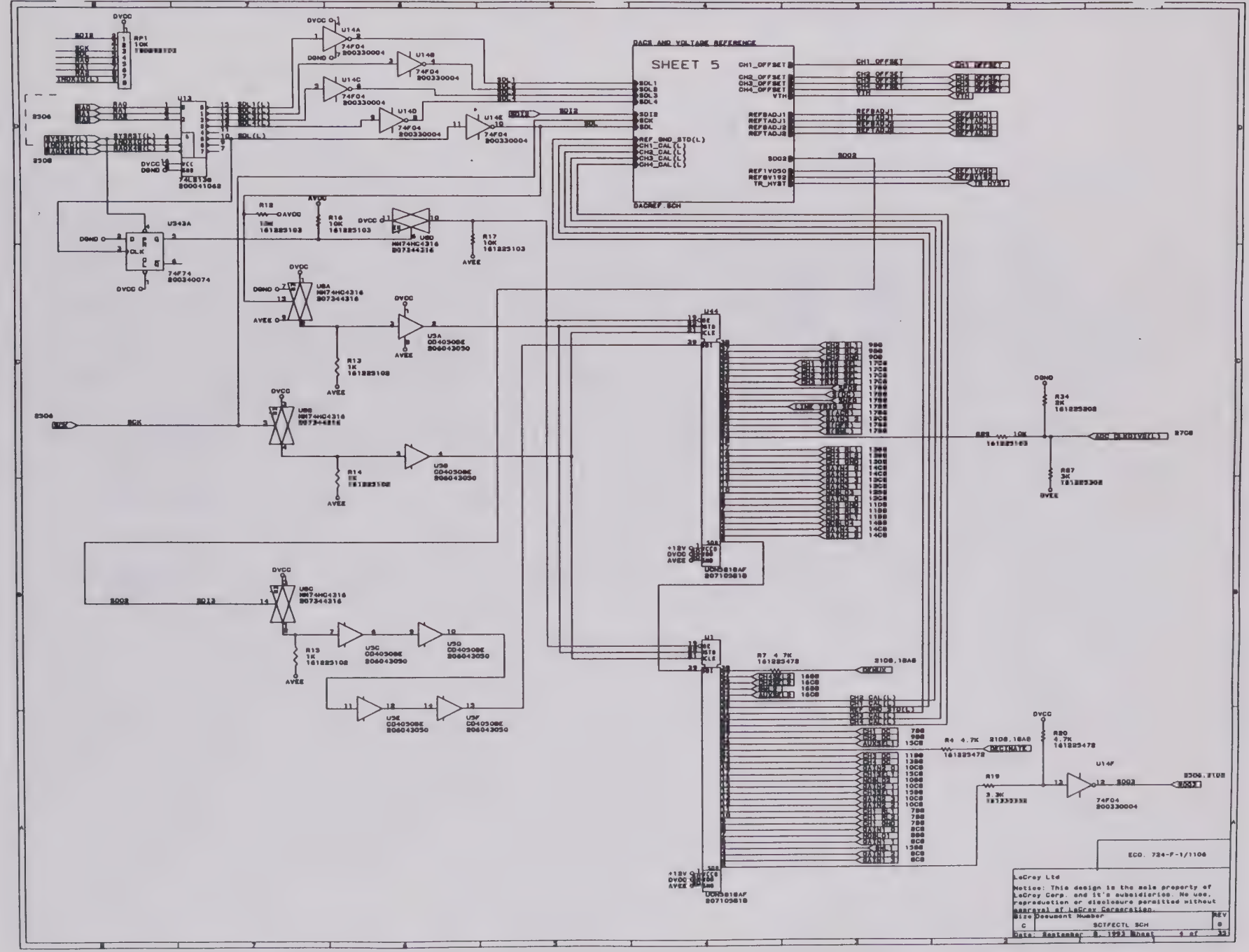
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ECO. 724-F-1/1106
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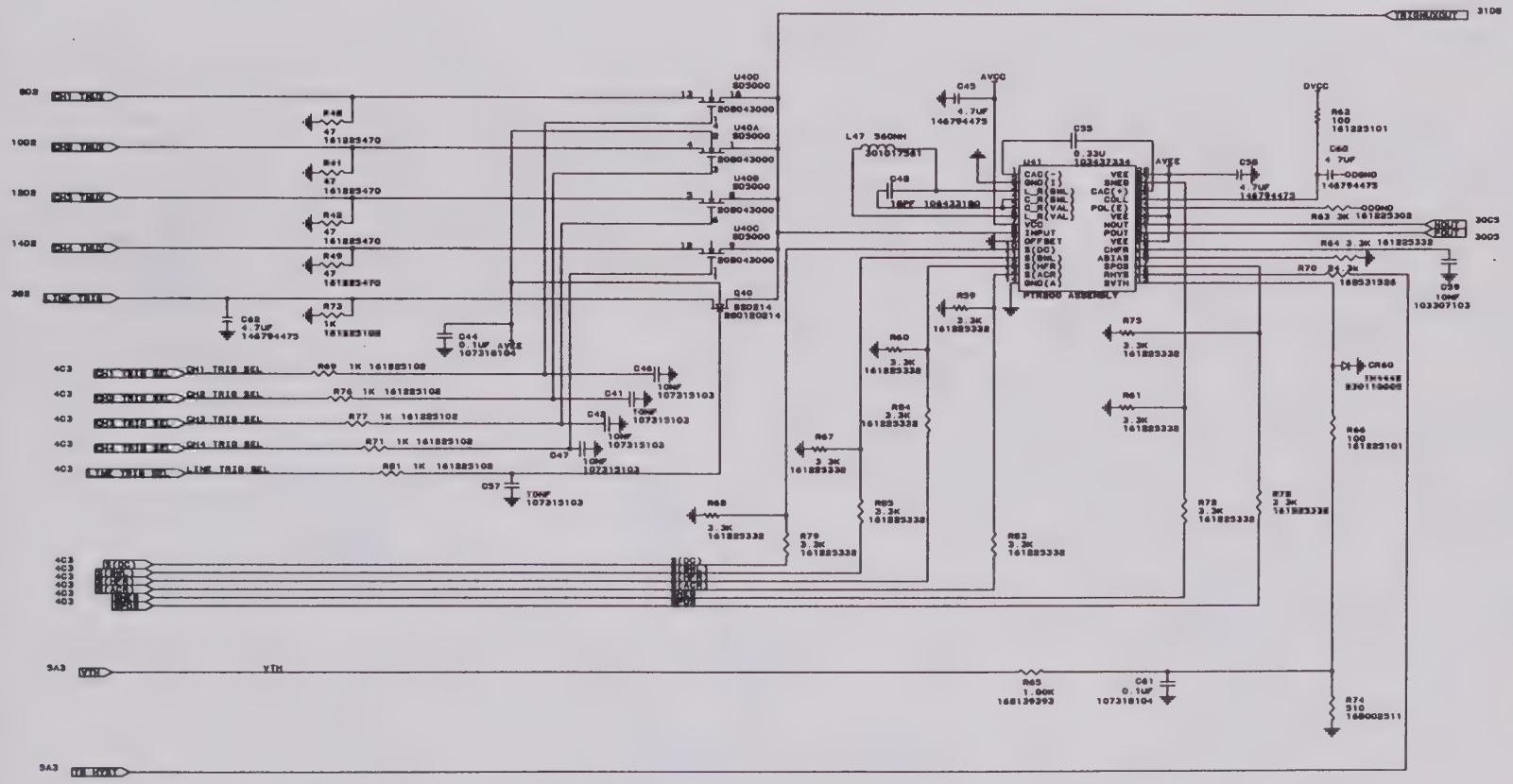

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Title

TRIGGER MUX & DISCRIMINATOR

Size	Document Number	REV
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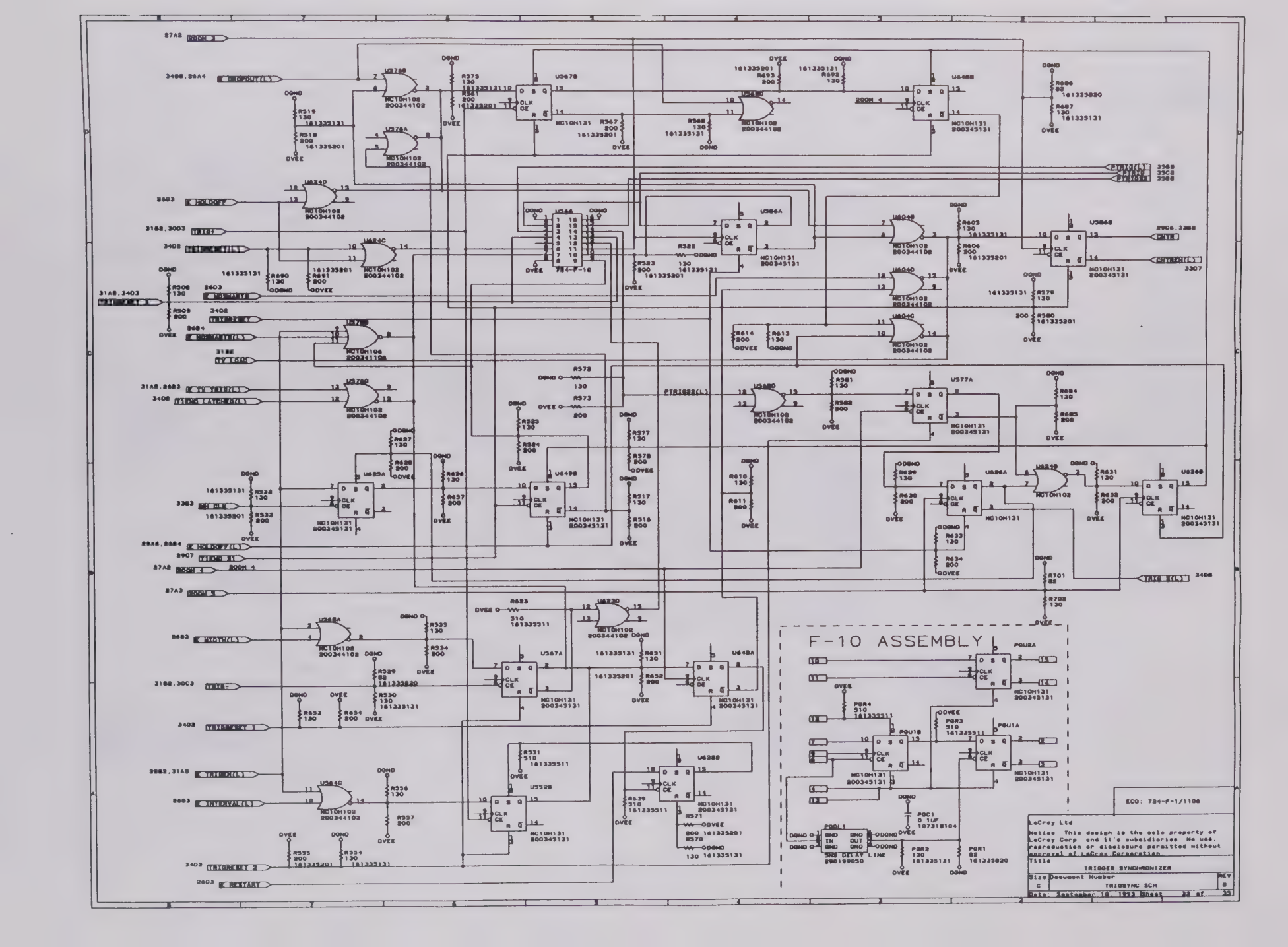
F-10 ASSEMBLY
ECO: 784-F-1/1106
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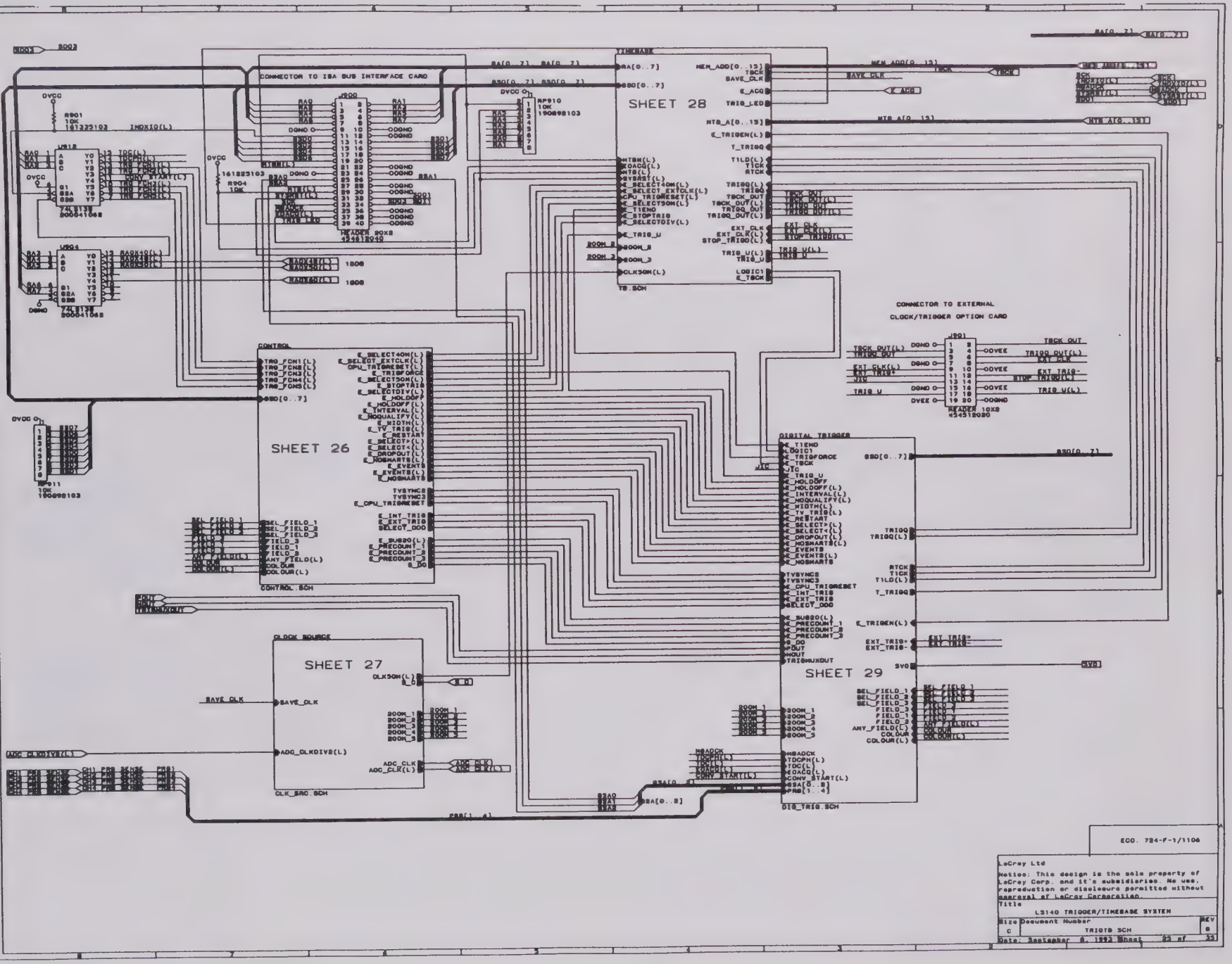
Title
TRIGGER SYNCHRONIZER
Size Document Number REV
C TRIGSYNC.SCH 0
Date: September 10, 1993 Sheet 32 of 33


SHEET 28
TB.SCH
SHEET 26
CONTROL.SCH
SHEET 27
CLK_SRC.SCH
SHEET 29
DIG_TRIG.SCH
CONNECTOR TO ISA BUS INTERFACE CARD
CONNECTOR TO EXTERNAL
CLOCK/TRIGGER OPTION CARD
DIGITAL TRIGGER
CONTROL
CLOCK SOURCE
TIMEBASE
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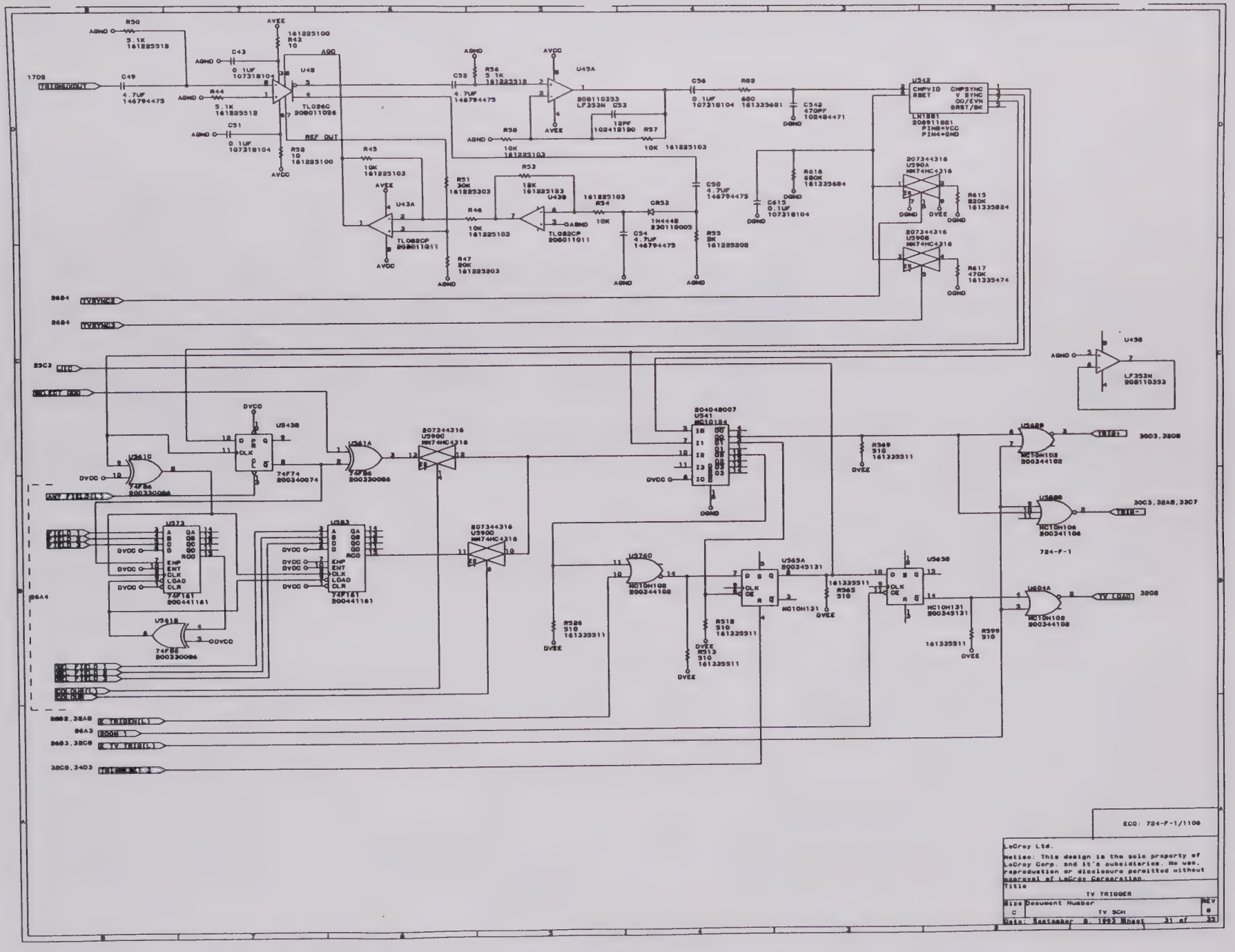
Title
LT340 TRIGGER/TIMEBASE SYSTEM
Size C
Document Number TRIGTB.SCH
REV B
Date: September 8, 1992 Sheet 23 of 33
ECO. 784-F-1/1106


TV TRIGGER
TV SCH
ECO: 724-F-1/1106
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Size C
Document Number
REV B
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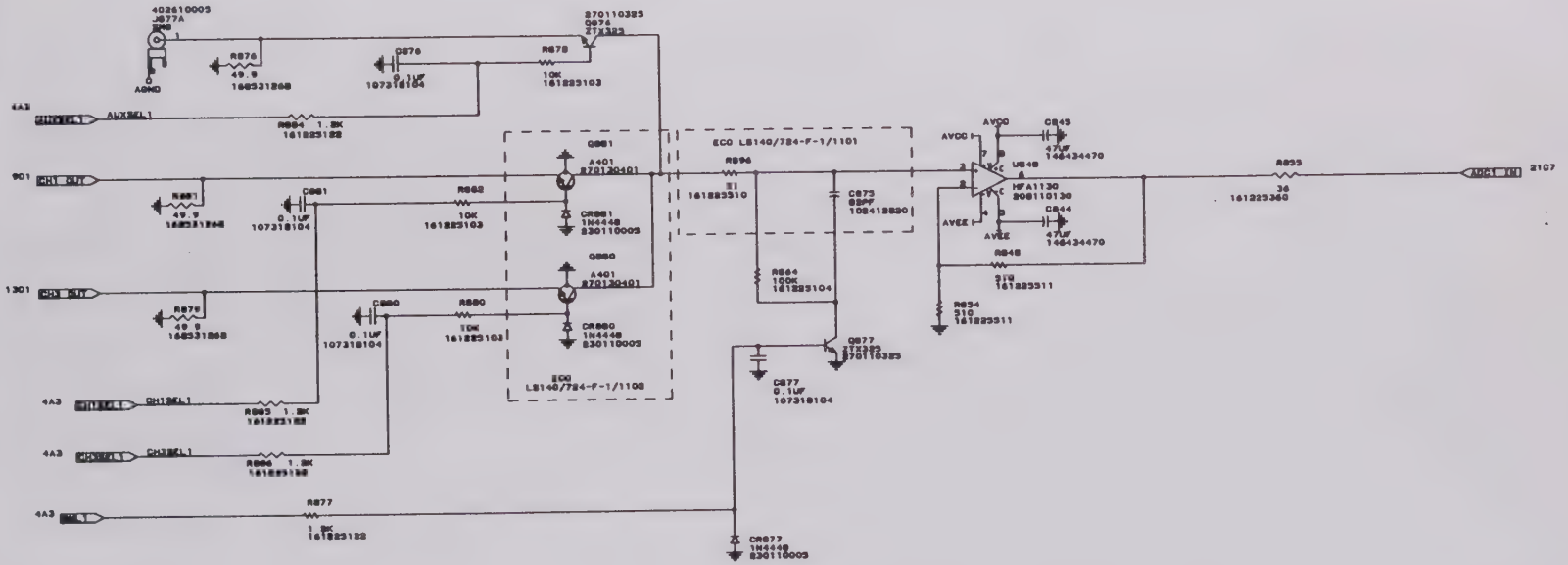

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Size	Document Number	REV
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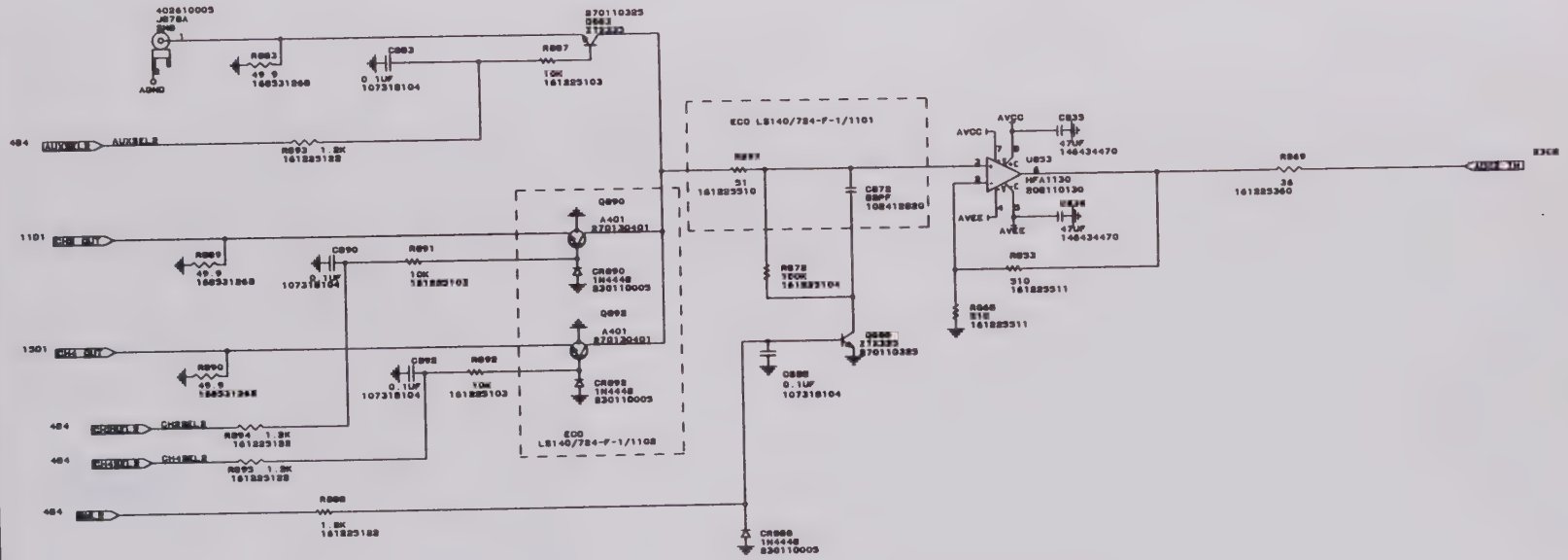

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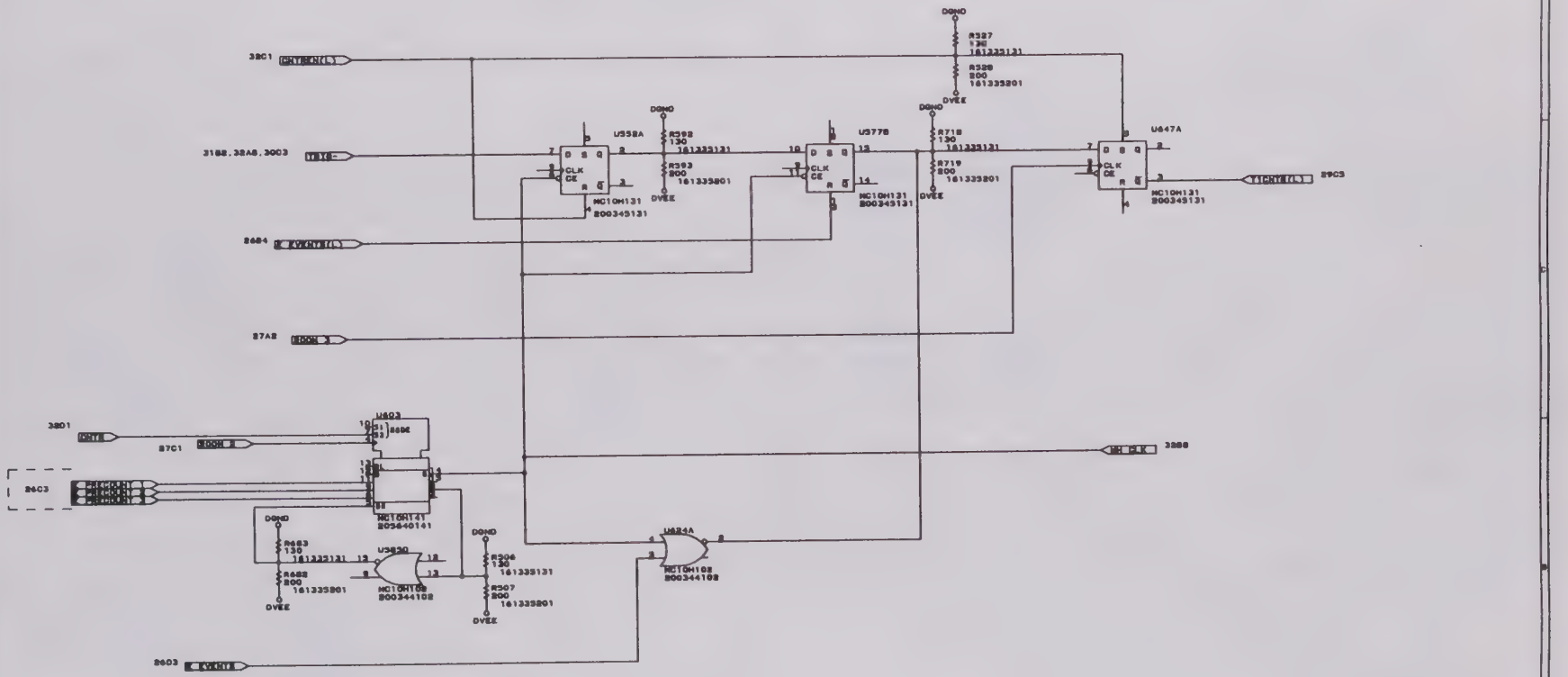

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Title: WIDTH/HOLDOFF CLOCK AND CONTROLLER

Size	Document Number	REV
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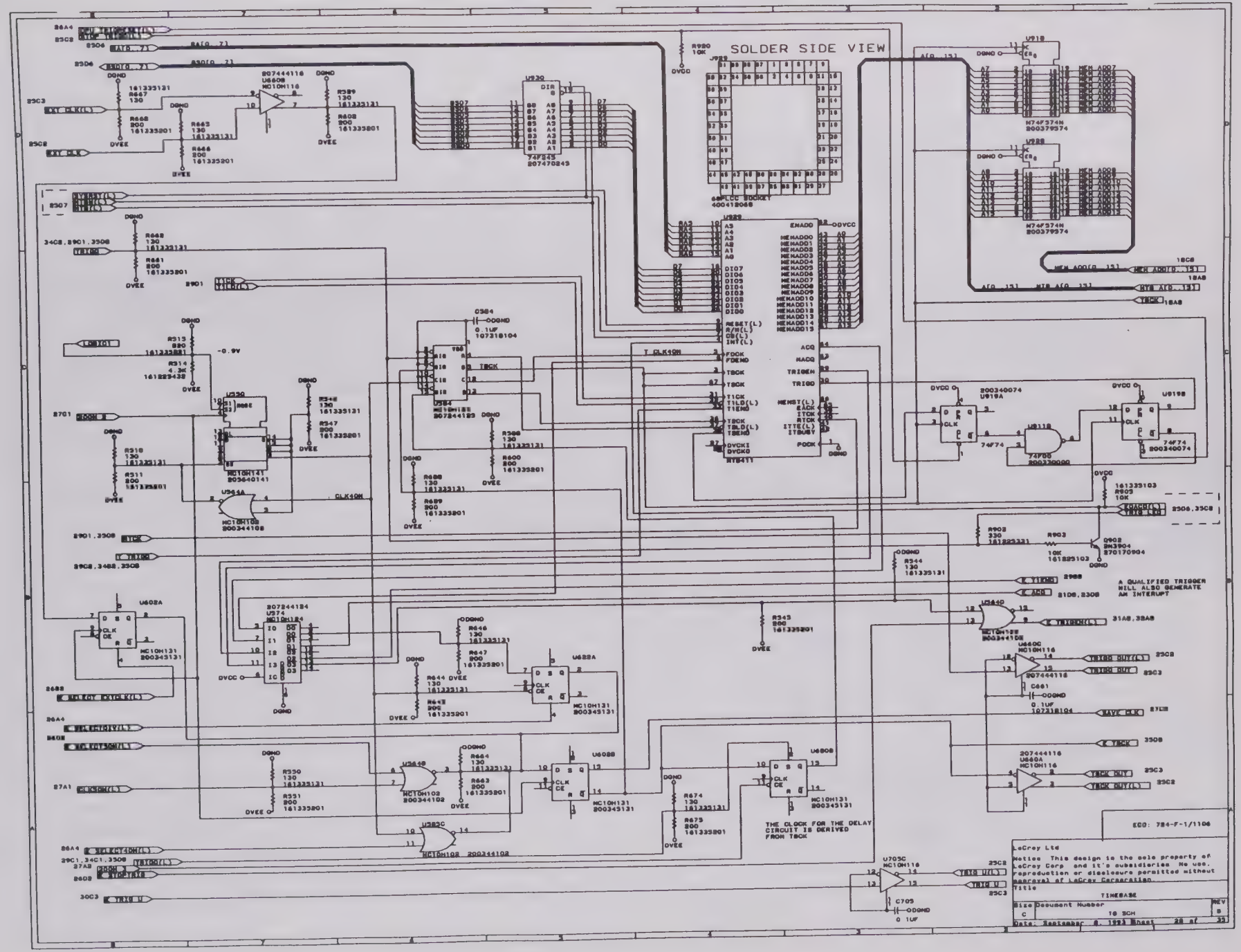
SOLDER SIDE VIEW
LeCroy Ltd
TIMEBASE
Size Document Number REV
C 10 SCH B
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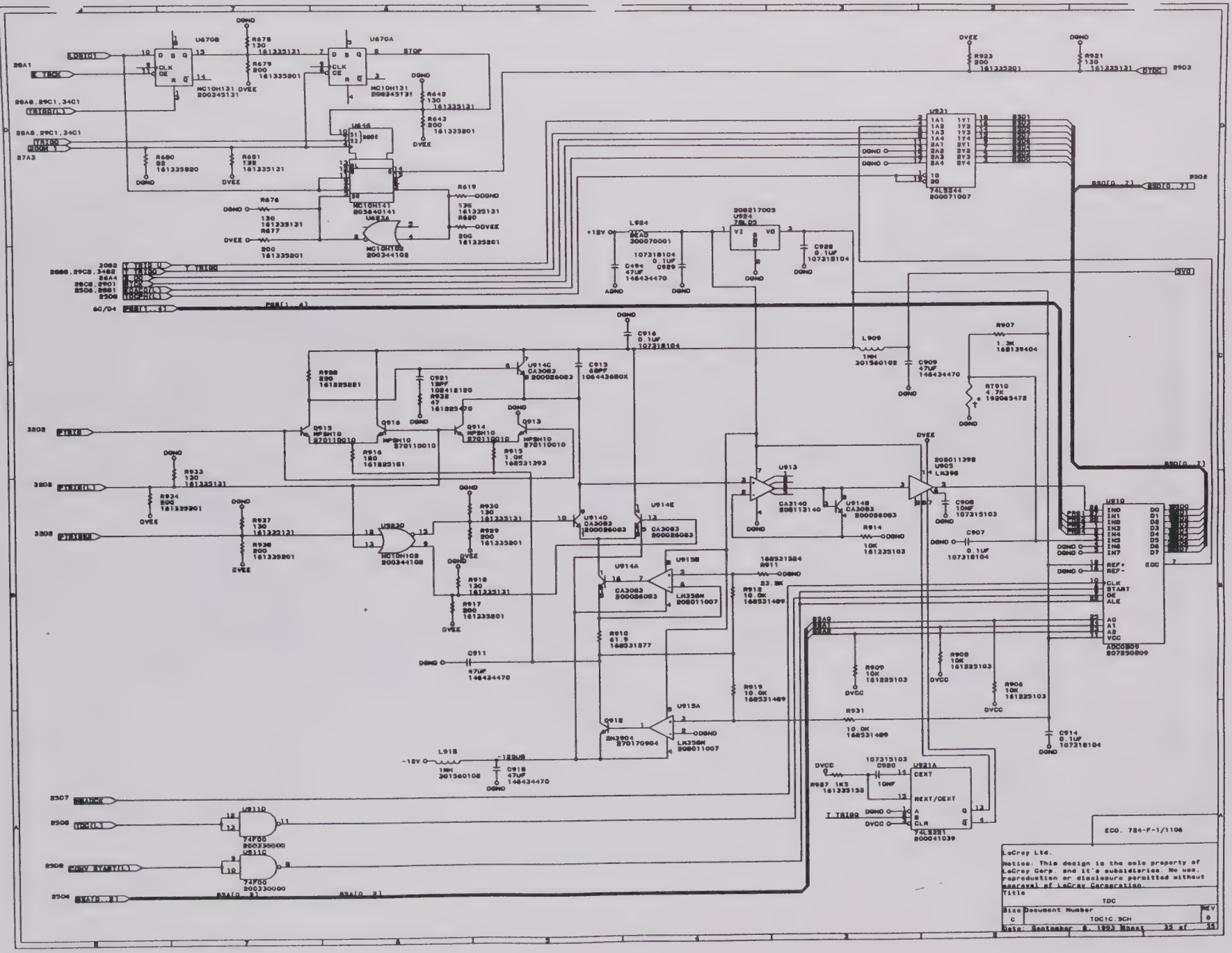
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Title
TDC
Size
Document Number
TDC1C.SCH
REV
Date: September 6, 1993
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LECROY LS140 DIGITAL OSCILLOSCOPE PARTS LIST

8.0 INTRODUCTION

This section contains the parts list for the LS140. It is divided into three categories: Suggested Spare Parts, Replaceable Parts, and Complete Parts. The Suggested Spare Parts list.details items that a facility should have on hand to enable immediate repair or in situations where the unit cannot be return to the manufacture for restoration. The Replaceable Parts list contains items that this manual will support replacing as well as the parts that will be readily available from our service centers. All of the parts on this list should be available within 24-36 hours upon request. The third list contains the full parts lists for all of the assemblies contained in the LS140.

8.1 SUGGESTED SPARE PARTS FOR LS140 SCOPESTATION

ASSEMBLY PART #	DESCRIPTION
724-F-1	MAIN ACQUISITION BOARD
724-F-2	FRONT PANEL
724-F-4	VGA DISPLAY BOARD
724-F-5	LS140 I/O BOARD
724-F-7	POWER SUPPLY INTERCONNECT BOARD
724-F-47	200 WATT POWER SUPPLY
724-F-48	PC-AT® MOTHER BOARD ASSEMBLY
200 906 002	AT BUS MULTI I/O CARD
200 906 012	GPIB BOARD
315 160 110	5V 6A POWER SUPPLY
321 210 099	MONOCHROME MONITOR KIT 9"
330 003 202	FLOPPY DRIVE 1.44MB
411 128 080	SWITCH ROCKER DPST
433 162 001	FUSE TIME LAG 250V 1A
433 162 010	FUSE TIME LAG 250V 10A
433 162 400	FUSE SLO-VLO 250V 4A
530 409 208	FAN WITH CONNECTOR
LS-NET	NETWORK CARD
LS-FAX	FAX/MODEM CARD

8.2 REPLACEABLE PARTS

8.2.1 Replaceable Parts For LS140 Assembly

ASSEMBLY PART #	DESCRIPTION	MANUFACTURER
200906002	AT BUS MULTI I/O CARD	VITEX JPDVAIDE-2SIPIG
315160110	POWER SUPPLY 5V 6A	POWERLINE SU40P10L
321210099	"MONITOR KIT 9" VGA	EVERSONIC ECM-90099
323120150	PROBE TYPE PP050 X10 150MHZ	MACOM/GREENPAR LTD
330003202	DISK DRIVE 1.44MB	TEAC FD-235HF-4291
335990037	BRACKET PERSONAL COMPUTER	GLOBE G37
377071025	LABEL FRONT	BRIMARGEN
377071026	LABEL FRONT - PROBE ADJUST	BRIMARGEN
377071027	LABEL FRONT - NAMEPLATE	BRIMARGEN
377071033	LABEL FRONT TYPE NUMBER	BRIMARGEN
377071042	LABEL REAR - CONTROL PORT	BRIMARGEN
377724079	LABEL REAR - MAINS	
411128080	SWITCH ROCKER DPST	RENDAR LTD MSR8#0
485003002	GROMMET OPEN 31.8PH/25.4B/1.6PT	PLASTIC & RUBBER GROM LTD 4030BF
485013032	MOLDED GROMMET STRIP 320MM	RICHCO MGS-2-01
487240072	WIRE ASSY INTERCON BD TO POW SWIT	
487240074	WIRE ASSY INTERCONN BD TO MONIT B	
487310035	CABLE ASSY-FLOPPY DISK DRIVE	
487310036	CABLE ASSY-MAIN BOARD TO I/O BOARD	
487310037	CABLE ASSY FRONT PNL TO I/O BOARD	
487310039	CABLE ASSY-VIDEO TO VGA BOARD	
500090110	FLAT WASHER FIBRE	PLASTIC SCREWS LTD 0380110
510400000	4MM GROUND INSERT	GREENPAR CONNECTORS 0122043
520013101	SPACER NYLON	BLUEMAY WESTON FSLEC1X1

8.2.1 Replaceable Parts For LS140 Assembly (continued)

ASSEMBLY PART #	DESCRIPTION	MANUFACTURER
530010401	RETRACTABLE TILT STAND	BUCKEYE STAMPING CO MP40008-3
530030050	HANDLE ASSEMBLY	AMERICAN HANDLE CO 186F-193-5050
530041009	LOCKING CIRCIUT BOARD SUPPORT	RICHCO LCBS-4
530409208	FAN WITH CONNECTOR (MODIFIED)	SUNONWEALTH MD1208PTB3
550020906	SCREW M3 HEX HD SLOTTED X 6MM	WEBB FASTERNERS
551135401	WASHER SHAKEPROOF M3.5	METRIC SCREW & TOOL
560440010	SCREW PHILIPS 4-40X5/8	PAN HD 18-8 STAINLESS
560632003	SCREW PHILIPS 6-32X3/16	PAN HD 18-8 STAINLESS
560632004	SCREW PHILIPS 6-32X1/4	PAN HD 18-8 STAINLESS
560632006	SCREW PHILIPS 6-32X3/8	PAN HD 18-8 STAINLESS
560632008	SCREW PHILIPS 6-32X1/2	PAN HD 18-8 STAINLESS
567032010	SCREW FLAT PHIL 6-32X5/8	82 DEG HD 18-8 STAINLESS
567632007	SCREW FLAT PHIL 6-32X7/16	82 DEGR HD 18-8 STAINLESS
568632004	SCREW FLAT PHIL 6-32X1/4	00 DEG HD 18-8 STAINLESS
568632007	SCREW FLAT PHIL 6-32X7/16	00 DEG HD 18-8 STAINLESS
575400012	WASHER PLAIN 4BA LARGE	WEBB FASTERNERS
577400001	WASHER SHAKEPROOF SIZE 4	
577600001	WASHER SHAKEPROOF SIZE 6	
580440001	NUT HEX STANDARD 4-40	18-8 STAINLESS STEEL
581632002	NUT HEX SMALL OD SS 6-32	
589203278	CORDSET 15AMP-125V U.S.A.& CANADA	FELLER
597724080	CARTON OSCILLOSCOPE	KAY METZELER 37650/1
597724081	ACCESSORY BOX	KAY METZELER 37650/1
597724082	PACKING INSERT	KAY METZELER 37650/1
597724083	END CAP FRONT (PACKING)	KAY METZELER 37650/1
597724084	END CAP REAR (PACKING)	KAY METZELER 37650/1
597724085	LOAD SPREADER FRONT (PACKING)	KAY METZELER 37650/1
597724086	LOAD SPREADER REAR (PACKING)	KAY METZELER 37650/1
597724090	CARTON 300K/T FLUTE CARDBOARD	KAY METZELER LTD 39606
597724091	INNER PACKING POLY GREY FOAM	KAY METZELER LTD 39605
598291002	PROBE ADJUST	ITT 011 1401 041609

8.2.1 Replaceable Parts For LS140 Assembly (continued)

ASSEMBLY PART #	DESCRIPTION	MANUFACTURER
707240050	FRONT COVER OSCILLOSCOPE	V.H. PREMISERVE
707240056	PLATE MOUNTING REAR	PLANET JIG AND TOOL
707240057	PLATE MOUNTING	PLANET JIG AND TOOL
707240075	COVER RIBBON CABLE	
707240279	CABLE PROTECTOR	
709714024	FOOT	RUBBERTECH 2000
709714028	CABINET, OSCILLOSCOPE	
709714034	BRACKET PCB MOUNTING	PLANET JIG & TOOL
709714045	SMART PROBE™ TYPE SP10X10 150MHZ	GREENPAR CONNECTORS LECROY SP10
724-F-1	LPS724 MAIN BOARD ASSEMBLY	
724-F-2	LPS724 FRONT PANEL BOARD ASSEMBLY	
724-F-3	LPS724 VIDEO INTERCONNECT BD ASSY	
724-F-4	LPS724 VGA CARD (MODIFIED)	
724-F-47	PSU 200W PS2/MODIFIED ASSY	
724-F-48	LPS724 PC-AT MOTHERBD ASSY	
724-F-49	LPS724 LINE PICKOFF TRANSFORMER	
724-F-5	LPS724 I/O BOARD ASSEMBLY	
724-F-7	PS INTERCONNECT BD ASSY	
729714001	CHASSIS-OSCILLOSCOPE	
729714002	REAR PANEL- CASTING	
729714003	KEYMAT ASSEMBLY	
729714004	CHASSIS, SIDE MEMBER	
729714012	SUB PANEL, FRONT (CASTING)	
729714019	SOCKET-GND	
729714020	NUT	
729714023	CONTROL KNOB	
729714025	SHIELD ELEC	
729714026	SHIELD ELECTRICAL	
729714027	CABLE ASSY - SPEAKER	
729714028	WIRE ASSY - PROBE ADJUST	
729714103	CHASSIS PART	
LS-OM	OPERATOR'S MANUAL	

8.2.2 Replaceable Parts For 724-F-1 Assembly

ASSEMBLY PART #	DESCRIPTION	MANUFACTURER
280124416	TRANSISTOR JFET "N" 2N4416	MOTOROLA 2N4416
402000001	CONN CO-AX BULKHD BNC	GREENPAR B35M18H999X99
430431001	RELAY 1 FORM C SPDT	FUJITSU FBR21D12
433162001	FUSE TIME LAG 250V 1A	BUSSMAN GMC 1A
433162010	FUSE TIME LAG 125V 10A	BUSSMAN GMC 10A
433162400	FUSE SLO-BLO 250V 4 AMP	SCHURTER FST 034-3123
434312056	FUSEHOLDER (CLIP)	SCHURTER OG751-0056
454111003	HDR SOLD TAIL/MALE 3	MOLEX 26-60-4030
454113012	HDR SOLD TAIL/MALE 12	MOLEX 26-60-4120
454114003	HEADER SOLD TAIL MALE 3	MOLEX 22-05-7038
454512020	HDR RT ANGLE SOLD TAIL/MALE 20	3M 2520-5002 UB
454612040	HDR RT ANGLE SOLD TAIL/MALE 40	3M 2540-5002 UB

8.2.3 Replaceable Parts For 724-F-2 Assembly

ASSEMBLY PART #	DESCRIPTION	MANUFACTURER
256532232	DIODE LED (GRN) TIL232-1	TI TIL232-1
412900036	SWITCH DIG ENCODER 36 POSITIONS	NOBLE SDB161PVF20 F-1-2-36PC
454512020	HDR RT ANGLE SOLD TAIL/MALE 20	3M 2520-5002 UB

8.2.4 Replaceable Parts For 724-F-47 Assembly

ASSEMBLY PART #	DESCRIPTION	MANUFACTURER
405580004	RING TERMINAL 4MM	JST SRA-51T-4
455021007	CONNECTOR CRIMP	MOLEX 08-70-1030

8.2.5 Replaceable Parts For 724-F-5 Assembly

ASSEMBLY PART #	DESCRIPTION	MANUFACTURER
334170001	REPLACEMENT LITHIUM CELL	TADIRAN TL5242/W
454114003	HEADER SOLD TAIL MALE 3	MOLEX 22-05-7038
454114004	HEADER SOLD TAIL 4	MOLEX 22-05-7048
454310002	HDR DIP SOLD TO PC BD 2	COMATEL 381-0543-1-02-400
454512020	HDR RT ANGLE SOLD TAIL/MALE 20	3M 2520-5002 UB
454612040	HDR RT ANGLE SOLD TAIL/MALE 40	3M 2540-5002 UB
560440004	SCREW PHILIPS 4-40X1/4	PAN HD 18-8 STAINLESS

8.2.6 Replacement Power Cords

ASSEMBLY PART #	DESCRIPTION	MANUFACTURER
589203274	CORDSET 10AMP INTERNATIONAL CONT EURO	FELLER
589203275	CORDSET 10AMP INTERNATIONAL BRITI	FELLER
589203276	CORDSET 10AMP INTERNATIONAL SWISS	FELLER
589203277	CORDSET 10AMP INTERNATIONAL ITALI	FELLER

8.3 LS140 COMPLETE PARTS LISTS

8.3.1 LS140 Parts List

ECO	PART #	DESCRIPTION REMARKS	QTY
2012	200906002	AT BUS MULTI I/O CARD	1
	315160110	POWER SUPPLY 5V 6A	1
	321210099	MONITOR KIT 9" VGA	1
	323120150	PROBE TYPE PP050 X10 150MHZ	3
	330003202	DISK DRIVE 1.44MB	1
	335990037	BRACKET PERSONAL COMPUTER	3
	377071025	LABEL FRONT	1
	377071026	LABEL FRONT - PROBE ADJUST	1
	377071027	LABEL FRONT - NAMEPLATE	1
	377071033	LABEL FRONT TYPE NUMBER	1
	377071042	LABEL REAR - CONTROL PORT	1
	377724079	LABEL REAR - MAINS	1
	377900002	END PRODUCT BAR CODE LABEL	1
	411128080	SWITCH ROCKER DPST	1
	485003002	GROMMET OPEN 31.8PH/25.4B/1.6PT	1
	485013032	MOLDED GROMMET STRIP 320MM	2
	487240072	WIRE ASSY INTERCON BD TO POW SWITCH	1
	487240074	WIRE ASSY INTERCONN BD TO MONIT BD	1
	487310035	CABLE ASSY-FLOPPY DISK DRIVE	1
	487310036	CABLE ASSY-MAIN BOARD TO I/O BOARD	2
	487310037	CABLE ASSY-FRONT PNL TO I/O BOARD	1
	487310039	CABLE ASSY-VIDEO TO VGA BOARD	1
	500090110	FLAT WASHER FIBRE	7
	510400000	4MM GROUND INSERT	1
	520013101	SPACER NYLON	7
	530041009	LOCKING CIRCUIT BOARD SUPPORT	5
	530409208	FAN WITH CONNECTOR (MODIFIED)	1
	550020906	SCREW M3 HEX HD SLOTTED X 6MM	4

8.3.1 LS140 Parts List (continued)

ECO	PART #	DESCRIPTION REMARKS	QTY
2012	560440010	SCREW PHILIPS 4-40 X 5/8"	?
	560632003	SCREW PHILIPS 6-32 X 3/16"	?
	560632004	SCREW PHILIPS 6-32 X 1/4"	?
	560632006	SCREW PHILIPS 6-32 X 3/8"	?
	560632008	SCREW PHILIPS 6-32 X 1/2"	?
	567032010	SCREW FLAT PHIL 6-32 X 5/8"	?
	567632007	SCREW FLAT PHIL 6-32 X 7/16"	?
	568632004	SCREW FLAT PHIL 6-32 X 1/4"	?
	568632007	SCREW FLAT PHIL 6-32 X 7/16"	?
	575400002	WASHER PLAIN 4BA SMALL	29
	575400012	WASHER PLAIN 4BA LARGE	4
	577400000	WASHER LOCK INT TOOTH 4BA	48
	580440000	NUT 4-40 UNC X 3/16"	9
	580632000	NUT 6-32 UNC X 5/16"	21
	594120001	TIEWRAP	4
	594423008	CABLE CLAMP NYLON	1
	598291002	PROBE ADJUST	1
	707240050	FRONT COVER OSCILLOSCOPE	1
	707240056	PLATE MOUNTING REAR	1
	707240057	PLATE MOUNTING	1
	707240075	COVER RIBBON CABLE	1
	707240279	CABLE PROTECTOR	2
	709714024	FOOT	4
	709714034	BRACKET PCB MOUNTING	2
	709714045	SMART PROBE TYPE SP10X10 150MHZ	1
	724-F-1	LPS724 MAIN BOARD ASSEMBLY	1
	724-F-2	LPS724 FRONT PANEL BOARD ASSEMBLY	1
	724-F-3	LPS724 VIDEO INTERCONNECT BD ASSY	1
	724-F-4	LPS724 VGA CARD (MODIFIED)	1

8.3.1 LS140 Parts List (continued)

ECO	PART #	DESCRIPTION REMARKS	QTY
2012	724-F-47	PSU 200W PS2/MODIFIED ASSY	1
	724-F-48	LPS724 PC-AT MOTHERBD ASSEMBLY	1
	724-F-49	LPS724 LINE PICKOFF TRANSFORMER	1
	724-F-5	LPS724 I/O BOARD ASSEMBLY	1
	724-F-52	LPS724 CABINET ASSEMBLY	1
	724-F-7	PS INTERCONNECT BD ASSY	1
	729714001	CHASSIS - OSCILLOSCOPE	1
	729714002	REAR PANEL - CASTING	1
	729714003	KEYMAT ASSEMBLY	1
	729714004	CHASSIS, SIDE MEMBER	1
	729714012	SUB PANEL, FRONT (CASTING)	1
	729714019	SOCKET - GND	1
	729714020	NUT	1
	729714023	CONTROL KNOB	1
	729714025	SHIELD ELEC	1
	729714026	SHIELD ELECTRICAL	1
	729714027	CABLE ASSY - SPEAKER	1
	729714028	WIRE ASSY - PROBE ADJUST	1
	729714103	CHASSIS PART	2
	LS-OM	OPERATOR'S MANUAL	1

8.3.2 724-F-1 Parts List

ECO	PART #	DESCRIPTION REMARKS	QTY
1102	102401472	CAP CERA DISC 1KV 4700 PF	4
	102412120	CAP CERA DISC 100V 12 PF	2
	102412820	CAP CERA DISC 100V 82 PF	2
	102480101	CAP CERA MONO 100V 100 PF	12
	102484471	CAP CERA DISC 100V 470 PF	1
	103307103	CAP CERA MONO 50V .01 UF	7
	103326683	CAP CERA MONO 50V .068UF	4
	103437334	CAP CERA MONO 100V .33 UF	1
	106313100	CAP CERA MONO 10 PF	6
	106415102	CAP CERA MONO .001UF	1
	106418104	CAP CERA MONO .1UF	4
	106433056	CAP CERAR MONO 5.6PF	4
	106433150	CAP CERA MONO 15PF	4
	106433180	CAP CERA MONO 18PF	1
	106443680X	CAP CERA MONO 68PF	1
	107315103	CAP CERA MONO AXIAL .01UF	49
	107318104	CAP CERA MONO AXIAL .1UF	129
	107415102	CAP CERA MONO AXIAL .001UF	12
	146434470	CAP MINI ALUM 20% 47 UF	50
	146794475	CAP MINI ALUM 4.7UF	21
	147236471	CAP ALUM METAL CAN 470 UF	1
	158849009	CAP VARIABLE .5 - 2.5 PF	4
	158849015	CAP VARI PTFE 2.5 - 18 PF	8
	161009107	RES METAL GLAZE 100 MEG	4
	161225100	RES CARBON FILM 10 OHMS	2
	161225101	RES CARBON FILM 100 OHMS	28
	161225102	RES CARBON FILM 1 K	17
	161225103	RES CARBON FILM 10 K	58
	161225104	RES CARBON FILM 100 K	2

8.3.2 724-F-1 Parts List (continued)

ECO	PART #	DESCRIPTION REMARKS	QTY
1102	161225105	RES CARBON FILM 1 MEG	4
	161225111	RES CARBON FILM 110 OHMS	2
	161225122	RES CARBON FILM 1.2 K	28
	161225123	RES CARBON FILM 12 K	1
	161225131	RES CARBON FILM 130 OHMS	20
	161225152	RES CARBON FILM 1.5 K	9
	161225161	RES CARBON FILM 160 OHMS	2
	161225181	RES CARBON FILM 180 OHMS	5
	161225201	RES CARBON FILM 200 OHMS	10
	161225202	RES CARBON FILM 2 K	6
	161225203	RES CARBON FILM 20 K	1
	161225221	RES CARBON FILM 220 OHMS	1
	161225300	RES CARBON FILM 30 OHMS	2
	161225302	RES CARBON FILM 3 K	4
	161225303	RES CARBON FILM 30 K	1
	161225331	RES CARBON FILM 330 OHMS	9
	161225332	RES COMP 1/8W 5% 3.3 K	21
	161225360	RES CARBON FILM 36 OHMS	2
	161225393	RES CARBON FILM 39 K	4
	161225432	RES CARBON FILM 4.3 K	1
	161225470	RES CARBON FILM 47 OHMS	21
	161225472	RES CARBON FILM 4.7 K	6
	161225510	RES CARBON FILM 51 OHMS	2
	161225511	RES CARBON FILM 510 OHMS	6
	161225512	RES CARBON FILM 5.1 K	3
	161225820	RES CARBON FILM 82 OHMS	22
	161225821	RES CARBON FILM 820 OHMS	4
	161225822	RES CARBON FILM 8.2 K	5
	161335103	RES CARBON FILM 10 K	4
	161335123	RES CARBON FILM 12 K	10

8.3.2 724-F-1 Parts List (continued)

ECO	PART #	DESCRIPTION REMARKS	QTY
1102	161335131	RES CARBON FILM 130 OHMS	86
	161335152	RES CARBON FILM 1.5 K	1
	161335201	RES CARBON FILM 200 OHMS	73
	161335240	RES CARBON FILM 24 OHMS	4
	161335332	RES CARBON FILM 3.3 K	1
	161335362	RES CARBON FILM 3.6 K	57
	161335474	RES CARBON FILM 470 K	
	161335511	RES CARBON FILM 510 OHMS	12
	161335681	RES CARBON FILM 680 OHMS	1
	161335684	RES CARBON FILM 680 K	1
	161335820	RES CARBON FILM 82 OHMS	14
	161335821	RES CARBON FILM 820 OHMS	3
	161335824	RES CARBON FILM 820 K	1
	161445010	RES CARBON FILM 1 OHM	2
	168002101	RES PREC METAL FILM 100 OHMS	4
	168002201	RES PREC METAL FILM 200 OHMS	4
	168002391	RES PREC METAL FILM 390 OHMS	4
	168002511	RES PREC METAL FILM 510 OHMS	13
	168008111	RES PREC METAL FILM 110 OHM	2
	168009105	RES ULTRA PREC 1 MEG	4
	168009904	RES ULTRA PREC 900K	8
	168091114	RES PREC 0.1% 111 K	8
	168095000	RES METAL FILM ZERO OHMS	3
	168139297	RES RN55E .1% 100 OHMS	4
	168139393	RES RN55E .1% 1.0 K	3
	168139404	RES RN55E .1% 1.30K	2
	168139550	RES RN55E .1% 43.2 K	8
	168139681	RES RN55E .1% 1.00 MEG	4
	168439461	RES RN55C .1% 5.11 K	1
	168531268	RES PREC RN55D 49.9 OHMS	10
	168531277	RES PREC RN55D 61.9 OHMS	1

8.3.2 724-F-1 Parts List (continued)

ECO	PART #	DESCRIPTION REMARKS	QTY
1102	168531337	RES PREC RN55D 261 OHMS	1
	168531381	RES PREC RN55D 750 OHMS	2
	168531393	RES PREC RN55D 1.00 K	1
	168531489	RES PREC RN55D 10.0 K	15
	168531524	RES PREC RN55D 23.2 K	1
	168531526	RES PREC RN55D 24.3 K	4
	168531673	RES PREC RN55D 825 K	4
	168539431	RES PREC FILM .1% 2.49 K	2
	168906220	RES METAL FILM 0.5W 0.22 OHM	1
	180909202	RES VARI CERMET 2K	4
	190892103	RES NETWORK 10K OHM	7
	190922001	RES NETWORK 160/240 OHMS	6
	192065472	THERMISTOR (NTC) 4.7 K	1
	195212006	VARISTOR 18V	4
	200026083	IC LINEAR TRANSISTOR ARRAY CA3083	2
	200041039	IC MONO/MULTIVIB N74LS221	1
	200041062	IC DEC/DEMULTP SN74LS138N	4
	200071007	IC BUFFER SN74LS244N	1
	200278406	IC BIN RIPPLE CTR HCT4060	1
	200330000	IC 2-INPUT NAND 74F00	2
	200330001	IC QUAD NOR CD4001BE	1
	200330004	IC FAST HEX INV 74F04	1
	200330086	IC EX-OR GATE 74F86	1
	200340074	IC D-TYPE POS FLOP 74F74	2
	200340210	IC 3-IN 3-OUT OR MC10H210	2
	200341106	IC 4-3-3 IN NOR 10H106	3
	200344102	IC QUAD 2-IN NOR 10H102	9
	200344104	IC QUAD 2-IN NAND 10H104	1
	200345131	IC DUAL D M-S FLOP 10H131	17
	200371273	IC OCTAL D-FLOP 74F273	2

8.3.2 724-F-1 Parts List (continued)

ECO	PART #	DESCRIPTION REMARKS	QTY
1102	200373374	IC D-TYP FLOP 74HCT374	5
	200379574	IC OCTAL D-TYP FLOP 74F574	6
	200441161	IC 4-BIT COUNTER 74F161	
	204042007	IC QUAD TRANSL MC10124P	1
	205210066	IC 256X16 EEPROM 93C66	1
	205281608	IC SRAM 2K X 8 MT5C1608	8
	205640141	IC SHIFT REGISTER 10H141	3
	205953116	IC BIPOLAR PAL TIBPAL16R8-7CN	1
	206043050	IC NON-INV BUFF CD4050BE	
	207105818	IC SOURCE DRIVER 32-OUT SERIAL IN	2
	207170541	IC BUFF/LINE DRIV 74LS541	12
	207174240	IC OCTAL 3-ST BUFF HCT240	1
	207241866	IC DUAL 16-BIT AUDIO DAC AD1866	2
	207244124	IC QUAD TTL-MECL 10H124	1
	207244125	IC QUAD MECL-TTL 10H125	2
	207250809	IC CMOS 8 CHANNEL 8-BIT SAR ADC	1
	207258840	IC OCTAL 8-BIT DAC SERIAL INPUT	1
	207344053	IC CMOS TRIPLE 2CH ANALOG MUX/DMUX	2
	207344316	IC QUAD ANALOG SWITCH HC4316	3
	207444116	IC TRIPL LINE RCVR 10H116	3
	207470245	IC BIDIRECT XVR 74F245	1
	207580557	TRANS ECL-TO-TTL TRANS 10KHT5574NT	8
	208011007	IC DUAL OP AMP LM358N	6
	208011011	IC JFET OP AMP TL082CP	1
	208011026	DIFFERENTIAL VIDEO AMP W/AGC	1
	208011398	IC MONO SAMPLE/HOLD LF398	1
	208031064	IC J-FET OP AMP TL064ACN	1
	208043000	IC 4X FET SWITCH SD5000	1
	208110007	IC LO OFFSET OP AMP OP-07	1
	208110130	IC OP AMP HFA1130	10
	208110353	IC DUAL OP AMP LF353N	1

8.3.2 724-F-1 Parts List (continued)

ECO	PART #	DESCRIPTION REMARKS	QTY
1102	208110708	IC DUAL OP AMP AD708	4
	208113140	IC OP AMP CA3140E	1
	208119630	IC BUFFER AMP 750MHZ	4
	208217005	IC VOLT REG +5V MC78L05AC	1
	208811689	IC VOLT REF 8.192V	1
	208911881	IC VIDEO SYNC SEPARATOR LM1881	1
	230110005	DIODE SWITCHING 1N4448	28
	230150045	DIODE PICOAMPERE BAV45	4
	235700001	DIODE DUAL HIGH SPEED COMMON ANODE	4
	253065822	DIODE SCHOTTKY 1N5822	4
	253150010	DIODE SCHOTTKY BAR10	1
	270110010	TRANSISTOR NPN MPSH10	8
	270110325	TRANSISTOR NPN ZTX325	32
	270130401	TRANSISTOR NPN A401	4
	270140095	TRANSISTOR NPN BFR95	2
	270170904	TRANSISTOR NPN 2N3904	6
	271174184	TRANSISTOR NPN UHF ON4184	4
	275170906	TRANSISTOR PNP 2N3906	6
	280120214	TRANSISTOR FET "N" BSD214	9
	280124416	TRANSISTOR JFET "N" 2N4416	4
	300070001	BEAD SHIELDING FERRITE WIRE-MOUNTED	17
	301017561	INDUCTOR MOLDED .56 UH	1
	301560102	INDUCTOR RADIAL 120MA 1MH	2
	302080123	INDUCTOR WOUND 12 UH	3
	302999123	INDUCTOR WOUND 6.3 UH/10AMP	1
	309001004	CRYSTAL OSC MODULE 4.096 MHZ	1
	309041220	CRYSTAL OSCILLATOR 200 MHZ	1
	400412068	IC SOCKET GRID TYPE 68-PIN	3
	402000001	CONN CO-AX BULKHD BNC	4
	402610005	CONN CO-AX PC MTG SMB	2
	430431001	RELAY 1 FORM C SPDT	12

8.3.2 724-F-1 Parts List (continued)

ECO	PART #	DESCRIPTION REMARKS	QTY
1102	433162001	FUSE TIME LAG 250V 1A	2
	433162010	FUSE TIME LAG 125V 10A	1
	433162400	FUSE SLO-BLO 250V 4 AMP	1
	434312056	FUSEHOLDER (CLIP)	8
	435110091	SURGE PROTECTOR G2470L	4
	454111003	HDR SOLD TAIL/MALE 3	1
	454113012	HDR SOLD TAIL/MALE 12	1
	454114003	HEADER SOLD TAIL MALE 3	1
	454512020	HDR RT ANGLE SOLD TAIL/MALE 20	1
	454612040	HDR RT ANGLE SOLD TAIL/MALE 40	2
	500610013	MOUNTING PAD TO-99	2
	500610014	MOUNTING PAD TO-18	16
	505112014	HEATSINK FOR 14/16 PIN DIP	4
	505168302	HEATSINK FOR 68LCC PACKAGE	2
	510160001	GROUND LUG SPADE TYPE	6
	590999026	WIRE 1/0.4 TEFLON/PTFE INS BLACK	0
	591101024	WIRE BUS TIN-COPP AWG 24	13
	597724090	CARTON 300K/T FLUTE CARDBOARD	0
	597724091	INNER PACKING POLY GREY FOAM	1
	717240103	PCB PRE-ASSY LS140/724-F-1	1
	724-F-10	LPS724 TDC DAUGHTER BOARD ASSY	1
	729714008	SHIELD, ATTENUATOR	4
	729714009	RACKET, BNC MTG	2
	729714010	SHIELD, COVER	1
	CH599011022	HEATSINK ADHESIVE CONDUCTIVE	0
	MAD200	IC MONO ADC 200MS 8-BIT FLASH	2
	MDX200	MONO MIN/MAX & DEMUX ASIC	2
	MTB411	IC TIME BASE GATE ARRAY MTB411	1
	PTR200	TRIGGER ADAPTOR/MTR408	1

8.3.3 724-F-5 Parts List

ECO	PART #	DESCRIPTION REMARKS	QTY
1006	103307103	CAP CERA MONO 50V .01 UF	1
	107315103	CAP CERA MONO AXIAL .01UF	1
	107318104	CAP CERA MONO AXIAL .1UF	33
	146434470	CAP MINI ALUM 20% 47 UF	2
	161225331	RES CARBON FILM 330 OHMS	3
	161335102	RES CARBON FILM 1 K	10
	161335103	RES CARBON FILM 10 K	9
	161335106	RES CARBON FILM 10 MEG	1
	168095000	RES METAL FILM ZERO OHMS	15
	190892102	RES NETWORK 1K OHM	3
	190892103	RES NETWORK 10K OHM	8
	200041062	IC DEC/DEMULTP SN74LS138N	1
	200071299	IC 8-BIT S/REG SN74LS299N	1
	200071377	IC 8XFLOP W/ENABL 74LS377	1
	200330008	IC 2-INPUT AND GATE 74F08	1
	200330033	IC QUAD 2-IN NOR SN74LS33	2
	200340074	IC D-TYPE POS FLOP 74F74	1
	200371273	IC OCTAL D-FLOP 74F273	1
	200372374	IC 8-BIT REGIST 74LS374	1
	200440040	IC 12-ST BIN COUNT HCT4040	1
	205034014	IC CMOS HEX SCHMITT 74HCT14	1
	205298128	IC 128K X 8 SRAM	4
	205910010	IC 1MBIT EPROM PROGR 27C010	1
	205959208	IC CMOS PROGRAMMED GAL20V8A-25	1
	205960208	IC CMOS PROGRAMMED GAL20V8-25	1
	205993000	IC CMOS PROGRAMMED GAL16V8-25	1
	205994000	IC CMOS PROGRAMMED GAL16V8-25	1
	207170541	IC BUFF/LINE DRIV 74LS541	4
	207176244	IC CMOS 3-STATE BUFFER HEF40244	1
	207470245	IC BIDIRECT XVR 74F245	2

8.3.3 724-F-5 Parts List (continued)

ECO	PART #	DESCRIPTION REMARKS	QTY
1106	227151211	IC NON VOLATILE RAM CONTROL DS1211	1
	253050817X	DIODE HOT CARRIER 1N5817	4
	270130401	TRANSISTOR NPN A401	4
	270140095	TRANSISTOR NPN BFR95	2
	270170904	TRANSISTOR NPN 2N3904	6
	271174184	TRANSISTOR	?
	301560102	INDUCTOR RADIAL 120MA 1MH	1
	312660002	BATTERY LITHIUM PC MTG 3V	1
	333400317	DR-DOS FIRMWARE LICENSE/KERNAL ONLY	1
	335990036	BRACKET PERSONAL COMPUTER	1
	400062032	SOCKET IC SOLD TAIL DIP-32	8
	416161002	SWITCH PUSHBUTTON SPST	1
	454114003	HEADER SOLD TAIL MALE 3	1
	454114004	HEADER SOLD TAIL 4	2
	454310002	HDR DIP SOLD TO PC BD 2	1
	454512020	HDR RT ANGLE SOLD TAIL/MALE 20	1
	454612040	HDR RT ANGLE SOLD TAIL/MALE 40	2
	530040216	BUZZER 3-9V 2KHZ	1
	560440004	SCREW PHILIPS 4-40X1/4	2
	597724090	CARTON 300K/T FLUTE CARDBOARD	0
	597724091	INNER PACKING POLY GREY FOAM	0
	717240502	PC BD PREASS'Y 724-F-5	1
	MFP414	IC MONO FRNT PANEL PROCESSOR MFP414	1

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